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The Sidereal System, Revised in 1887. By Maxwell Hall.

Ten years have now elapsed since my article on "The Sidereal System" appeared in vol. xliii. of the *Memoirs of the Royal Astronomical Society*, and during this time much work has been done in sidereal astronomy: the annual parallaxes of several more stars have been ascertained by different observers and computers; the velocities of stars along the line of sight have formed a special branch of investigation at the Royal Observatory, Greenwich; Dr. Gill, at the Royal Observatory, Cape of Good Hope, has found that the parallax of about $0''{\cdot}936$ ascribed to the star *α Centauri* * by his predecessors Henderson and Maclear is a little too large, and has thereby confirmed the researches of Dr. Elkin; and, lastly, the Greenwich observations show that the radial velocity of *Sirius* is variable,† and the curve of variation indicates that any constant part will prove to be small, so that theory and observation agree in the case of this important star.

These considerations render a revision of that article highly advisable; and we feel encouraged to take a somewhat wider view of the system than was possible in our first attempt; for we had then but few stars to deal with, and the general assump-

* One of the three stars employed in the former determination of the constants of the system.

† Reference was made in the first article to an assumed variation in consequence of the orbital motion of *Sirius* as a binary star, and the connection requires special investigation. A note will be found at the end of this article respecting the curve of variation.

tion of circular motion round the centre was absolutely necessary; but now we may discriminate, and say that among the elliptic orbits of the stars there must be several nearly circular, so that by assuming them to be truly circular the constants of the system may be accordingly determined.

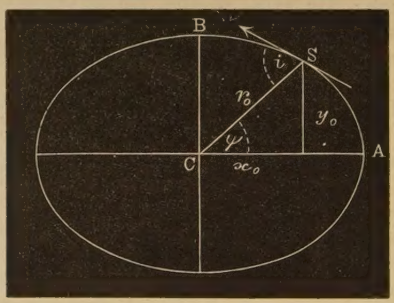
This wider and doubtless more correct view of the sidereal system requires but little change among our former equations; by means of proper motions we must compute parallaxes and radial velocities as before; and if in the case of any star the difference between observation and computation be large, or if the computation breaks down by assigning a negative parallax, the orbit cannot be circular and the star cannot assist us in the determination of the constants of the system.

But before dismissing such a star we may first ascertain whether its orbit be slightly or highly elliptic, for while we are prepared to admit into the sidereal system a large proportion of moderately elliptic orbits, a preponderance of highly elliptic orbits would throw great doubt upon our investigations.

There will, therefore, be three classes of orbits: those which are either circular or nearly so, those which are moderately elliptic, and those which are highly elliptic.

Stars which move in the last class of orbits will generally have large proper motions; and that such stars should have been selected for observation of annual parallax may be regarded as unfortunate for our problem, for we have thus forced upon us, as it were, an undue proportion of stars whose abnormal velocities and orbits must always distract our attention.

Let us now consider the motion of a star in the plane of its elliptic orbit about the centre, C.



Let a_0' and b_0'* be the semi-major and semi-minor axes C A and C B; and taking these rectangular axes as the axes of Cartesian co-ordinates, we have:

* The unit of space in quantities marked with these suffixes is the distance of a star whose parallax is 1″; in all other quantities the unit is the mean distance of the Earth from the Sun.

$$\frac{d^2x}{dt^2} = -\mathrm{F}x_0,$$

$$\frac{d^2y}{dt^2} = -\mathrm{F}y_0;$$

$$\left(\frac{dx}{dt}\right)^2 = \mathrm{F}(a_0'^2 - x_0^2)$$

$$\left(\frac{dy}{dt}\right)^2 = \mathrm{F}(b_0'^2 - y_0^2);$$

and

$$v^2 = \mathrm{F}(a_0'^2 + b_0'^2 - r_0^2) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (\mathrm{V})$$

where F, v, and r_0 have the same significance as in the original article.

Again, let ψ be the angle ACS, or the eccentric anomaly; then

$$x_0 = a_0' \cos\psi\,;\ y_0 = b_0' \sin\psi\,;$$

$$\frac{dx}{dt} = -\sqrt{\mathrm{F}}\,.\,a_0' \sin\psi\,;\ \frac{dy}{dt} = \sqrt{\mathrm{F}}\,.\,b_0' \cos\psi\,;$$

so that if h be twice the area swept over by the radius vector in the unit of time,

$$h = x\frac{dy}{dt} - y\frac{dx}{dt} = a'b'\sqrt{\mathrm{F}}\,.\,\sin 1'',$$

and the period of revolution is

$$\frac{2\pi}{\sqrt{\mathrm{F}}\,.\,\sin 1''}.$$

Now let i be the angle between the radius SC and the direction of motion of the star; then

$$v\cos i = \frac{dr}{dt} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (\mathrm{VI})$$

and

$$h = vr\sin i,$$

so that

$$vr_0 \sin i = a_0' b_0' \sqrt{\mathrm{F}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (\mathrm{VII})$$

Equation (V) can be rendered more convenient for our present purposes. Let

$$a_0'^2 + b_0'^2 = 2r_0^2 + \frac{\Lambda}{\mathrm{F}}v^2;$$

then

$$v^2 = \mathrm{F}r_0^2 + \Lambda v^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

and in the case of the solar orbit,

$$\mathrm{V}^2 = \mathrm{F}\mathrm{R}_0^2 + \Lambda\mathrm{V}^2.$$

But we shall still consider the solar orbit to be circular, as in the former article, although indeed we recognise the necessity of determining its ellipticity at some future time; therefore we shall put $\Lambda = o$.

Substituting for the equations (I) and (II) in the former article in (13), we have

$$\left(\frac{d\rho}{dt}\right)^2 + 2a\mathrm{V}\frac{d\rho}{dt} + (c^2 - \Pi^2\mathrm{V}^2)\rho_0^2 + 2\mathrm{V}(b - \mathrm{H}\Pi\mathrm{V})\rho_0 = \Lambda v^2 \quad . \quad . \quad . \quad (14)$$

Again, for elliptic orbits, equation (III) in the former article becomes

$$\frac{d\rho}{dt}(\mathrm{H} + \Pi\rho_0) + \rho_0(\mathrm{K} + a\Pi\mathrm{V}) + \Gamma\mathrm{V} = \Pi r_0 \frac{dr}{dt};$$

and remembering that

$$\Gamma\mathrm{V} = \frac{d\mathrm{R}}{dt} = 0,$$

we have

$$\frac{d\rho}{dt}(\mathrm{H} + \Pi\rho_0) + \rho_0(\mathrm{K} + a\Pi\mathrm{V}) = \Pi r_0 \frac{dr}{dt} \quad . \quad . \quad . \quad . \quad . \quad (15)$$

Now when both ρ_0 and $\frac{d\rho}{dt}$ are known, of course Λv^2 becomes known from (14), and $\frac{dr}{dt}$ from (15). When only ρ_0 or $\frac{d\rho}{dt}$ is known, Λv^2 is indeterminate; but in many cases we may assign to Λv^2 its lowest value, so that the quadratic equation may have possible and equal roots, or so that the resulting value of $\frac{dr}{dt}$ from (15) may be fairly in accordance.

Thus no value of Λv^2 can be assumed in (14) which would make cos i in (VI) greater than unity; and no value of Λv^2 should be assumed in (14) which would make cos i unnecessarily large.

Again, when Λv^2 and $\frac{dr}{dt}$ are known, or roughly approximated, the corresponding values of r_0, v, and i become known; also $(a_0'^2 + b_0'^2)$ and $a_0' b_0'$; so that a_0' and b_0' are known; and finally we have the ellipticity of the orbit, which is

$$\frac{a_0' - b_0'}{a_0'}.$$

Let us take as an example the star 17,415 Oeltzen; * it was shown that when the proper motions of this star are employed in the general formulæ, p. 186 of the original article, the resulting parallax has a negative sign; consequently the orbit of this star cannot be circular.

The observed parallax is $0''.247$; therefore ρ_0 is 4·05, and equation (14) becomes

$$\left(\frac{d\rho}{dt}\right)^2 + 16{\cdot}3\frac{d\rho}{dt} = \Lambda v^2 - 84{\cdot}7,$$

so that

$$\left(\frac{d\rho}{dt} + 8{\cdot}15\right)^2 = \Lambda v^2 - 18{\cdot}3.$$

* No. 67 in the following tables.

Consequently the least possible value of Δv^2 is $+18{\cdot}3$; and then $\frac{d\rho}{dt}$ becomes $-8{\cdot}15$.

Substituting these values of ρ_0 and $\frac{d\rho}{dt}$ in equation (15), we get

$$\Pi r_0 \frac{dr}{dt} = +5{\cdot}9.$$

But $r_0 = 149$ from (I); so that

$$\Pi r_0 = 0{\cdot}99,$$

and

$$\frac{dr}{dt} = +6{\cdot}0.$$

Again, from (II) or (13), $v = 10{\cdot}7$; so that from (VI), $\cos i = 0{\cdot}56$; consequently while Δv^2 indicates a very small ellipticity, $\cos i$ indicates a much larger one.

Let us therefore assume

$$\Delta v^2 = +118{\cdot}3;$$

then

$$\frac{d\rho}{dt} = +1{\cdot}85, \quad \frac{dr}{dt} = +2{\cdot}7, \quad v = 14{\cdot}7,$$

and

$$\cos i = 0{\cdot}18,$$

so that

$$i = 80°.$$

Now, while we cannot say which of these two solutions is the more correct, we prefer the latter, and place the star 17·415 Oeltzen among those of the second class whose orbits are moderately elliptic.

Proceeding with the latter solution, $(a_0'^2 + b_0'^2) = 71461$, $a_0' b_0' = 32623$; $a_0' = 224$, $b_0' = 146$; and the ellipticity $= 0{\cdot}35$.

Let us take as another example the star 1830 Groombridge*; when the proper motions of this star are employed in the general formulæ, the resulting parallax becomes far too large, and therefore the orbit of this star cannot be circular.

The observed parallax may be taken as $0''{\cdot}145$; therefore ρ_0 is $6{\cdot}90$; and equation (14) becomes

$$\left(\frac{d\rho}{dt}\right)^2 + 8{\cdot}3\frac{d\rho}{dt} = \Delta v^2 - 2476,$$

so that

$$\left(\frac{d\rho}{dt} + 4{\cdot}15\right)^2 = \Delta v^2 - 2459.$$

Consequently the least possible value of Δv^2 is $+2459$; and then

$$\frac{d\rho}{dt} = -4{\cdot}15.$$

* No. 62 in the following tables.

Substituting these values of ρ_0 and $\frac{d\rho}{dt}$ in equation (15) we get

$$\Pi r_0 \frac{dr}{dt} = +39{\cdot}2,$$

so that

$$\frac{dr}{dt} = +39;$$

and as $v = 51$, $\cos i = 0{\cdot}76$, and $i = 40°{\cdot}5$.

The orbit of the star 1830 Groombridge is therefore highly elliptic; and proceeding numerically, $a_0' = 774$, $b_0' = 98$, and the ellipticity $= 0{\cdot}87$.

Remembering that the radius of the solar orbit was found to be 150, it appears that the semi-major axis of this star is about five times as large; and in the solar system we are well acquainted with such relations between planetary and cometary orbits.

The following table requires but little explanation; the stars are arranged according to magnitude; the magnitudes given are for the most part the means of the results found by Professors Pritchard and Pickering; the Right Ascensions are given in time to the nearest second, but in the calculations they were previously expressed in arc to the nearest minute; the columns "P.M. in R.A." and "P.M. in N.P.D." give the proper motions in Right Ascension and North Polar Distance respectively, and the latter have been taken, when possible, from the papers of Professors Main and Stone in vols. xix., xxviii., and xxxiii., of the *Memoirs of the Royal Astronomical Society*; and a list of the proper motions taken from other authorities will be found at the end of this article, together with notes on the annual parallaxes and radial velocities which have been adopted.

It will be noticed that instead of merely indicating to which class the orbit of any star belongs, the adopted values of Av^2 and $\Pi r_0 \frac{dr}{dt}$ have been tabulated; when an orbit is assumed to be circular, these values are of course zero; when an orbit is assumed to be elliptic the values given are those which were roughly adopted as previously explained.

It will be convenient to reproduce the formulæ given in the first article,* p. 186, and to add those required for elliptic orbits.

Formulæ.

θ = North Polar Distance
ϕ = Right Ascension
} of a star, Jan. 1·0, 1850;

$\delta\theta$ = Annual proper motion in θ
$\delta\phi$ = Annual proper motion in ϕ
} in seconds of arc;

* A small list of *errata* in that article will be found in the *Monthly Notices*, vol. xxxix. p. 133.

ϖ = Annual parallax, in seconds of arc;

ρ_0 = Distance in sidereal units $= \frac{1}{\varpi}$;

$\frac{d\rho}{dt}$ = Annual change in distance, taking the radius of the Earth's orbit as the unit of space.

$$\begin{aligned} l &= \sin\theta\cos\phi, & \delta l &= n\delta\theta\cos\phi - m\,\delta\phi, \\ m &= \sin\theta\sin\phi, & \delta m &= n\delta\theta\sin\phi + l\,\delta\phi, \\ n &= \cos\theta, & \delta n &= -\sin\theta\,\delta\theta. \end{aligned}$$

$$\begin{aligned} a &= l\lambda + m\mu + n\nu, & \log\lambda &= -9{\cdot}16642, \\ b &= \lambda\delta l + \mu\delta m + \nu\delta n, & \log\mu &= -9{\cdot}91350, \\ c^2 &= \delta l^2 + \delta m^2 + \delta n^2, & \log\nu &= +9{\cdot}74360. \end{aligned}$$

$$\begin{aligned} \mathrm{H} &= l\mathrm{L} + m\mathrm{M} + n\mathrm{N}, \\ \mathrm{K} &= \mathrm{L}\delta l + \mathrm{M}\delta m + \mathrm{N}\delta n, \end{aligned} \qquad \begin{aligned} \log\mathrm{L} &= -9{\cdot}94601, \\ \log\mathrm{M} &= -9{\cdot}15806, \\ \log\mathrm{N} &= -9{\cdot}64992. \end{aligned}$$

For Circular Orbits.

$$u = \frac{\mathrm{K} + a\Pi\mathrm{V}}{\mathrm{H} + \Pi\rho_0};$$

$$\varpi = \frac{c^2 + u^2 - \Pi^2\mathrm{V}^2}{2\mathrm{V}(au - b + \mathrm{H}\Pi\mathrm{V})};$$

$$\begin{aligned} \log\Pi &= 7{\cdot}82282, \\ \log\Pi\mathrm{V} &= 8{\cdot}82034, \\ \log\,2\mathrm{V} &= 11{\cdot}29855, \\ \Pi^2\mathrm{V}^2 &= 0{\cdot}004. \end{aligned}$$

$$\frac{d\rho}{dt} = -\frac{u}{\varpi}.$$

For Elliptic Orbits.

$$\left(\frac{d\rho}{dt}\right)^2 + 2a\mathrm{V}\frac{d\rho}{dt} + (c^2 - \Pi^2\mathrm{V}^2)\rho_0^2 + 2\mathrm{V}(b\mathrm{H}\Pi\mathrm{V})\rho_0 = \Lambda v^2;$$

$$\frac{d\rho}{dt}(\mathrm{H} + \Pi\rho_0) + \rho_0(\mathrm{K} + a\Pi\mathrm{V}) = \Pi r_0\frac{dr}{dt};$$

$$r_0^2 = \mathrm{R}_0^2 + \rho_0^2 + 2\mathrm{H}\mathrm{R}_0\rho_0;$$

$$v^2 = \mathrm{V}^2 + \left(\frac{d\rho}{dt}\right)^2 + 2\mathrm{V}\left(a\frac{d\rho}{dt} + b\rho_0\right) + c^2\rho_0^2,$$

or more simply

$$v^2 = \mathrm{F}r_0^2 + \Lambda v^2;$$

$$v\cos i = \frac{dr}{dt}.$$

$$\begin{aligned} \log\,2\mathrm{R}_0 &= 12{\cdot}47821, \\ \log\,\mathrm{F} &= 7{\cdot}64068; \\ \mathrm{R}_0^2 &= 22613, \\ \mathrm{V}^2 &= 98{\cdot}9. \end{aligned}$$

No.	Star	M	R.A. 1850 h m s	P.M. in R.A. s	N.P.D. 1850 ° ′	P.M. in N.P.D ″
1	α Canis Maj. (*Sirius*)	−1·2	6 38 32	−0·035	106 31	+1·24
2	α Argûs (*Canopus*)	−0·4	6 20 37	−0·002	142 37	−0·03
3	α Centauri	0·0	14 29 27	−0·484	150 13	−0·75
4	α Boötis (*Arcturus*)	0·0	14 8 49	−0·079	70 2	+1·93
5	α Aurigæ (*Capella*)	0·1	5 5 37	+0·008	44 10	+0·43
6	α Lyræ (*Vega*)	0·2	18 31 51	+0·017	51 21	−0·28
7	β Orionis (*Rigel*)	0·2	5 7 20	−0·001	98 23	+0·02
8	α Canis Min. (*Procyon*)	0·5	7 31 27	−0·048	84 24	+1·08
9	α Orionis	0·9	5 47 3	+0·001	82 38	0·00
10	α Aquilæ (*Altair*)	1·0	19 43 28	+0·036	81 32	−0·38
11	β Centauri	1·0	13 53 17	−0·010	149 39	+0·05
12	α Tauri (*Aldebaran*)	1·1	4 27 19	+0·004	73 48	+0·17
13	α Virginis (*Spica*)	1·1	13 17 18	−0·005	100 23	+0·04
14	β Gemin. (*Pollux*)	1·2	7 36 8	−0·049	61 37	+0·06
15	α Leonis (*Regulus*)	1·3	10 0 23	−0·019	77 18	−0·01
16	α Cygni	1·4	20 36 19	−0·002	45 15	0·00
17	α Gemin. (*Castor*)	1·5	7 25 1	−0·013	57 47	+0·08
18	ε Ursæ Majoris	1·8	12 47 25	+0·013	33 14	+0·05
19	α Persei	1·9	3 13 38	+0·002	40 41	+0·05
20	β Tauri	1·9	5 16 49	+0·003	61 31	+0·20
21	α Andromedæ	2·1	0 0 39	+0·009	61 44	+0·15
22	β Ceti	2·1	0 36 3	+0·013	108 49	−0·02
23	α Ursæ Min. (*Polaris*)	2·1	1 5 1	+0·065	1 29	0·00
24	α Arietis	2·1	1 58 44	+0·012	67 15	+0·15
25	γ Cassiopeæ	2·2	0 47 42	−0·008	30 6	−0·02
26	γ Leonis	2·2	10 11 42	+0·019	69 24	+0·15
27	ζ Ursæ Majoris	2·2	13 17 53	+0·017	34 17	+0·04
28	α Ophiuchi	2·2	17 27 58	+0·004	77 20	+0·20
29	α Coronæ	2·3	15 28 20	+0·009	62 47	+0·07
30	γ Cygni	2·3	20 16 51	0·000	50 13	−0·02
31	β Cassiopeæ	2·4	0 1 12	+0·063	31 41	+0·19
32	β Ursæ Majoris	2·4	10 52 45	+0·010	32 49	−0·03
33	γ Ursæ Majoris	2·4	11 45 55	+0·011	35 28	0·00
34	γ Draconis	2·4	17 53 8	0·000	38 29	+0·04

Observed			Assumed		Computed				
ϖ	ρ_0	$\frac{d\rho}{dt}$	Δv	$\Pi r_0 \frac{dr}{dt}$	ϖ	ρ_0	$\frac{d\rho}{dt}$	$\Delta\varpi$	$\Delta\frac{d\rho}{dt}$
"					"			"	
0·268	3·73	− 2·1?	0	0	0·210	4·76	− 0·5	+0·058	−1·6?
0·028	35·7	...	− 12·5	+ 7·5	...	...	+19·2	...	...
0·765	1·31	...	0	0	0·909	1·10	− 2·6	−0·144	...
0·132	7·52	−15·9	0	0	0·188	5·33	−14·5	−0·056	−1·4
0·046	21·7	+ 9·0	0	0	0·029	34·4	+ 8·7	+0·017	+0·3
0·128	7·81	−12·4	0	0	0·069	14·5	−18·7	+0·059	+6·3
...	...	+ 6·6	− 75	− 3·1	0·015	66·7	...	...	...
0·123	8·13	+ 5·3	0	0	0·074	13·5	+ 8·6	+0·049	−3·3
...	...	+ 9·3	0	0	0·017	60·0	+14·4	...	−5·1
0·181	5·53	− 8·6	0	0	0·146	6·87	−14·1	+0·035	+5·5
0·0?	large	...	0	0	0·001	701	+ 2·2	0·0?	...
...	..	+11·0	0	0	0·018	56·8	+14·2	...	−3·2
...	...	− 4·1	0	0	0·001	948	− 5·6	...	+1·5
...	...	−11·0	+196	− 10·3	0·060	16·6	...	...	...
...	...	+ 3·5	0	0	0·020	50·4	+ 9·6	...	−6·1
0·0?	large	−11·7	0	0	0·004	282	−14·9	0·0?	+3·2
0·198	5·05	+ 6·1	− 12·8	− 0·9	...	...	...	...	...
...	...	+ 4·1	+168	+ 6·4	0·019	51·5	...	...	...
...	...	− 9·6	+ 50·3	− 6·2	0·005	204	...	...	...
...	...	− 4·9	+ 14·8	+ 3·0	0·026	38·0	...	...	...
...	...	− 9·7	+ 49·1	+ 5·1	0·017	59·0	...	...	...
...	...	−11·5	+206	+ 4·5	0·034	29·5	...	...	...
0·043	23·3	...	0	0	0·008	133	−12·6	+0·035	...
...	...	− 4·9	+ 1·5	+ 5·1	0·030	33·0	...	...	...
...	...	− 6·7	+100	+ 5·0	0·022	43·6	...	...	...
...	...	− 9·0	+185	+ 0·6	0·034	29·0	...	...	...
...	...	+ 6·7	+200	+ 3·6	0·038	26·0	...	...	...
...	...	− 3·8	+100	+ 9·1	0·012	87·0	...	...	...
...	...	+ 7·2	+200	+ 5·1	0·036	28·1	...	...	...
...	...	− 4·6	− 15·4	+ 4·7	0·010	97·0	...	...	...
...	...	-- 0·4	− 6·9	− 1·9	0·065	15·4	...	...	...
...	...	+ 7·9	+230	+ 5·5	0·017	60·0	...	...	...
...	...	+ 6·0	+200	+ 6·5	0·016	61·0	...	...	...
0·092	10·9	− 2·5	− 0·6	+ 0·5	0·150	6·67	0·0	...	...

No.	Star	M	R.A. 1850 h m s	P.M. in R.A. s	N.P.D. 1850 ° ′	P.M. in N.P.D. ″
35	ϵ Pegasi	2·4	21 36 49	+0·003	80 49	0·00
36	α Pegasi	2·4	22 57 18	+0·003	75 36	+0·02
37	α Cephei	2·6	21 15 0	+0·021	28 3	−0·01
38	γ Pegasi	2·8	0 5 31	0·000	75 39	+0·02
39	γ Virginis	2·8	12 34 4	−0·037	90 38	+0·05
40	γ Aquilæ	2·8	19 39 8	+0·001	79 45	0·00
41	δ Cygni	2·9	19 40 17	+0·006	45 14	0·00
42	β Cygni	3·0	19 24 40	−0·002	62 21	0·00
43	ζ Aquilæ	3·1	18 58 31	−0·006	76 21	+0·07
44	ι Ursæ Majoris	3·2	8 48 55	−0·047	41 22	+0·28
45	δ Andromedæ	3·3	0 31 19	+0·009	59 58	+0·10
46	η Cassiopeæ	3·5	0 40 3	+0·132	32 59	+0·49
47	70 p. Ophiuchi	4·3	17 57 53	+0·015	87 28	+1·12
48	e Eridani	4·4	3 13 55	+0·270	133 39	−0·75
49	o^2 Eridani	4·4	4 8 22	−0·148	97 53	+3·46
50	δ Ursæ Minoris	4·4	18 20 44	+0·048	3 24	−0·03
51	σ Draconis	4·7	19 32 38	+0·096	20 36	+1·79
52	ζ Toucani	5·0	0 12 12	+0·273	155 45	−1·16
53	61 Cygni	5·0	21 0 11	+0·342	51 59	−3·11
54	μ Cassiopeæ	5·2	0 58 19	+0·386	35 49	+1·56
55	ϵ Indi	5·2	21 51 51	+0·480	147 24	+2·60
56	Cephei 51 (Hev.)	5·3	6 28 33	−0·027	2 45	+0·08
57	85 Pegasi	5·8	23 54 21	+0·067	63 43	+0·95
58	3077 Bradley	5·9	23 6 4	+0·250	33 40	−0·27
59	6 B. Cygni	6·0	19 8 12	−0·015	40 25	−0·62
60	Piazzi III. 242	6·5	3 57 35	+0·017	52 20	+0·15
61	1618 Groombridge	6·5	10 2 6	−0·139	39 48	+0·50
62	1830 Groombridge	6·5	11 44 19	+0·344	51 12	+5·70
63	21,185 Lalande	7·5	10 55 8	−0·044	53 2	+4·66
64	9352 Lacaille	7·5	22 56 10	+0·567	126 43	−1·31
65	34 Groombridge	8·0	0 9 52	+0·255	46 50	−0·37
66	21258 Lalande	8·5	10 58 0	−0·386	45 42	−1·36
67	17415 Oeltzen	9·0	17 37 17	−0·070	21 33	+1·20
68	11677 Oeltzen	9·5	11 12 0	−0·507	23 20	−0·21

Observed			Assumed				Compute		
ϖ	ρ_0	$\frac{d\rho}{dt}$	Δv	$\Pi r_0 \frac{dr}{dt}$	ϖ	ρ_0	$\frac{d\rho}{dt}$	$\Delta\varpi$	$\frac{dp}{dt}$
"					"			"	
...	...	− 4·9	0	0	0·009	106	− 8·2	...	+3·3
...	...	− 8·8	0	− 0·9	0·006	155	...	...	...
...	...	−14·4	0	0	0·016	63·7	−14·2	...	−0·2
...	...	− 8·1	+136	+ 1·2	0·008	129	...	...	...
...	...	+ 8·6	+ 31·3	+ 9·3	0·060	16·7	...	...	...
...	...	− 8·4	0	0	0·013	75 0	−15·5	...	+7·1
...	...	− 5·1	− 60·9	0·0	0·012	80·0	...	...	...
...	...	− 4·9	+105	+ 7·7	0·008	119	...	...	...
...	...	− 7·9	− 37·6	+ 7·0	0·020	50·0	...	...	...
0·133	7·52	...	0	− 0·9	...	...	+ 7·0	...	...
...	...	−14·0	+143	+ 9·7	0·023	43·2	...	...	...
0·154	6·49	...	0	0	0·065	15·3	− 4·4	+0·089	...
0·160	6·25	...	0	0	0·111	9·00	−17·1	+0·049	...
0·136	7·35	...	0	0	0·328	3·05	+17·6	−0·192	...
0·194	5·16	...	+424	− 2·8	...	...	+ 8·6	...	...
0·034	29·4	...	0	0	0 015	65·7	−12·4	+0·019	...
0·255	3·92	...	+ 43·6	+ 1·7	...	...	− 7·6	...	...
0·057	17·5	...	+795	−22·8	...	...	+ 5·8	...	...
0·441	2·27	...	0	0	0·422	2·37	−10 5	+0·019	...
0·342	2·92	...	0	0	0·199	5·02	− 2·5	+0·143	...
0·215	4·65	...	+100	− 0·5	...	...	+10·8	...	...
0·027	37·0	...	0	0	0·037	27·0	+ 1·6	−0·010	...
0·050	20·0	...	0	0	0 071	14·0	− 2·0	−0·021	...
0·185	5·40	...	0	0	0·126	7·91	− 5·8	+0·059	...
0·482	2·07	...	0	+ 0·1	...	...	0·0	...	...
0·016	62·5	...	0	0	0·028	35·0	+ 8·9	−0·012	...
0·322	3·11	...	0	− 0·3	...	...	+ 5·8	...	...
0·145	6·90	...	+2459	+39·2	...	...	− 4·2	...	...
0·501	2·00	...	+ 70	+ 2·7	...	...	−12·2	...	...
0·285	3·51	...	+1000	− 6·1	...	...	−19·5	...	...
0·307	3·26	...	0	0	0·195	5·14	− 1·0	+0·112	...
0·261	3·83	...	+ 800	− 4·0	...	...	+22·1	...	...
0·247	4·05	...	+ 118	+ 2·7	...	...	+ 1·8	...	...
0·256	3·91	...	+1600	− 2·0	...	...	−45·9	...	...

This table contains the computations for all stars whose annual parallaxes have been ascertained, and of all stars whose radial velocities have been determined at Greenwich with a moderate degree of certainty.

With regard to the Greenwich observations of radial velocities published in the *Monthly Notices of the Royal Astronomical Society*, vols. xxxvi., xxxvii., xxxviii., xli., xlii., xliii., xliv., and xlv., the stars were divided into three classes: (1) those whose radial velocities can be depended on in consequence of the number and the agreement of the observations; (2) those whose radial velocities are less certain; and (3) those whose radial velocities cannot be depended on in consequence of the small number of the observations or of want of agreement among them.

Stars of the third class have not been considered in the above table; and indeed many stars of the second class have radial velocities assigned to them which are far from reliable.

Let us take as an example the star ϵ *Ursæ Majoris*, and collect all the observations of its radial velocity published in the volumes referred to above:

Date.	Miles per sec.
1877, May 2	+ 5·9
1879, May 21	+ 24·4
„ June 9	+ 9·8
1880, May 22	+ 0·2
„ June 4	+ 15·4
1883, July 13	+ 2·1
„ Aug. 21	+ 24·8
Mean	+ 11·8

And dividing by 2·9 we have $\frac{d\rho}{dt} = +4{\cdot}1$ as adopted in the table; and consequently we have an elliptic orbit for the star.

But in vol. xlvi. of the *Monthly Notices*, published after the commencement of the present revision, we find that on Aug. 10, 1885, a radial velocity of $-41{\cdot}7$ miles per second was observed at Greenwich; so that ϵ *Ursæ Majoris* should be placed in the third class at present, and rejected.

This latter radial velocity has, however, been confirmed by Mr. G. M. Seabroke at Rugby, who found -32 miles per second (*Monthly Notices*, vol. xxxix., p. 453); so that $\frac{d\rho}{dt}$ may be about -8 instead of $+4{\cdot}1$. Now if the orbit of ϵ *Ursæ Majoris* be assumed circular, we would have $\varpi = 0''{\cdot}044$, $\rho_0 = 22{\cdot}8$, and $\frac{d\rho}{dt} = -7{\cdot}4$; and it thus appears that the orbit of this star is most probably circular, although our systematic computations require us to assume it to be elliptic.

This example has been given, not to detract from the value of the Greenwich observations of radial velocity, but to point out as clearly as possible that most of the results which have been obtained up to the present time cannot be regarded as even approximately final, and must therefore be accepted with great caution.

There is therefore no reason to be dissatisfied with the results of our systematic computations given in the table above; in the case of 37 stars observed for annual parallax, 21 have circular, 11 have moderately elliptic, and 5 have highly elliptic orbits;* in the case of 40 stars, including *Sirius*, observed for radial velocity, 14 have circular, 24 have moderately elliptic, and 2 have highly elliptic orbits.†

It will be noticed that stars observed for radial velocity do not, on the whole, give such good results as stars observed for annual parallax; one reason, that of uncertainty of observation, has just been discussed; another reason will, perhaps, be found in the uncertainty attending the very small proper motions attributed to many of these stars. In the first article it was considered right to omit all stars which have very small proper motions; but this restriction was removed in the computations above, and the results apparently justify its removal, as we cannot attribute to chance the circularity of the orbits of α *Orionis*, α *Cygni*, ϵ *Pegasi*, and γ *Aquilæ*. The uncertainty, however, may exist, although we are not at present entitled to reject stars however small their proper motions. And a third reason will probably be found by combining the enormous distances of many of these stars with our present imperfect knowledge of the sidereal system. Therefore, by taking into consideration all the sources of error, we have no reason to be dissatisfied, as already said, with the general results we have obtained.

In an article "On the Theory of the Sidereal System," which was written by Mr. W. E. Plummer, and which appeared in *Copernicus*, No. 15, March 1882, we find that the formulæ of the original article were applied to stars whose radial velocities had been observed at Greenwich between the years 1875 and 1880. There were 90 of these stars, but the greater portion were rejected on account of their small proper motions, and a few were omitted as having been already examined in the original article, so that but 40 remained for computation.

Now of these 40 stars, 26 still belong to what we have termed the third class, 11 belong to the second class, and only 3 to the first class; and, rejecting the third class altogether, we find considerable differences between the remaining radial velocities obtained at that and the present time. For instance, $\frac{d\rho}{dt}$ for β *Cassiopeæ* was then $+12{\cdot}8$; it is now $-0{\cdot}4$; and $\frac{d\rho}{dt}$ for α *Persei* was then

* Nos. 2, 52, 62, 64, and 68. † Nos. 39 and 43.

+7·9; it is now −9·6. In short, the data were not reliable, and disappointment was the consequence.

But, on the other hand, I have to thank Mr. Plummer for pointing out an error in the computation of 21185 *Lalande* given in the *Monthly Notices*, vol. xxxix. p. 132, which has of course been corrected in the table above, and for calling attention to the proper motions of the stars generally. As already stated, Mr. Main's proper motions have been systematically employed in the original and present articles; but Mr. Plummer used proper motions, or the means of proper motions, given by various authorities. By such procedure we might easily have found proper motions to suit such stars as *γ Draconis*, *ι Ursæ Majoris*, 6 B. *Cygni*, 1618 Groombridge, and others, whose orbits are now very slightly elliptic, and thus have largely increased the number of circular orbits. What we really require is a careful determination of the proper motions of all stars whose annual parallaxes and radial velocities have been observed; and until this be done we shall adopt Mr. Main's proper motions as heretofore.

We have now passed through our tentative stage, and found a system which satisfies our principal stars, *Sirius*, *Arcturus*, *Capella*, *Vega*, *Procyon*, and *Altair* in both distant and radial velocity; which satisfies a number of stars in either distance or radial velocity; and which, upon the assumption of moderately elliptic orbits, satisfies the rest of the stars subjected to computation with but few exceptions.

It still remains to form equations of condition in order to find corrections to the adopted values of L, M, N, Π, and V; there will be twenty-one such equations depending upon annual parallax, and there will be fourteen depending upon radial velocity.

In the original article the formation of such equations depending upon annual parallax was fully discussed, and we need only reproduce the formulæ.

Let

$$S=\frac{\varpi\left(aV+\frac{d\rho}{dt}\right)}{H+\Pi\rho_0};$$

$$p=\frac{\nu L-\lambda N}{\mu N-\nu M};\ \log p=-10{\cdot}09515$$

$$q=\frac{\lambda M-\mu L}{\mu N-\nu M};\ \log q=-10{\cdot}19763$$

$$U=\delta l+p\delta m+q\delta n-u(l+pm+qn);$$

$$\tfrac{1}{2}\frac{d\epsilon}{d\varpi}=V(au-b+H\Pi V)+u\rho_0{}^2S\Pi;$$

$$\tfrac{1}{2}\frac{d\epsilon}{dL}=SU+\varpi\Pi V^2(l+pm+qn);$$

$$\tfrac{1}{2}\frac{d\epsilon}{dV}=\varpi(au-b+H\Pi V)+aS\Pi+V\Pi^2+\varpi H\Pi V;$$

$$\tfrac{1}{2}\frac{d\epsilon}{d\Pi}=S\left(a\,V+\frac{d\rho}{dt}\right)+\varpi V^2(H+\Pi\rho_0);$$

$$A=\frac{\dfrac{d\epsilon}{dL}}{\dfrac{d\epsilon}{d\varpi}};\quad C=\frac{\dfrac{d\epsilon}{dV}}{\dfrac{d\epsilon}{d\varpi}};\quad E=\frac{\dfrac{d\epsilon}{d\Pi}}{\dfrac{d\epsilon}{d\varpi}};$$

then

$$A\,.\,\Delta L+C\,.\,\Delta V+E\,.\,\Delta\Pi+\Delta\varpi=0,$$

is the equation for the determination of ΔL, ΔV, and $\Delta\Pi$, the corrections which must be added to the adopted values of L, V, and Π, where $\Delta\varpi$ is the difference between the observed and the computed parallax. And lastly $\Delta M=p\,.\,\Delta L$, $\Delta N=q\,.\,\Delta L$.

In order to form similar equations depending on $\Delta\frac{d\rho}{dt}$, the difference between the observed and the computed radial velocity, since

$$\frac{d\rho}{dt}=-u\rho_0,$$

we have

$$\Delta\frac{d\rho}{dt}=\frac{\Delta\varpi}{\varpi^2}\left(u-\varpi\frac{\Delta u}{\Delta\varpi}\right);$$

but

$$\frac{\Delta u}{\Delta\varpi}=\frac{du}{d\varpi}=\frac{u\rho_0{}^2\Pi}{H+\Pi\rho_0}\ *;$$

so that

$$\Delta\frac{d\rho}{dt}=\frac{\Delta\varpi}{\varpi^2}\cdot\frac{uH}{H+\Pi\rho_0},$$

or

$$\Delta\varpi=\Delta\frac{d\rho}{dt}\cdot\frac{\varpi^2(H+\Pi\rho_0)}{uH}.$$

If, therefore, in the case of any star we multiply $\Delta\frac{d\rho}{dt}$ by the factor

$$\frac{\varpi^2(H+\Pi\rho_0)}{uH},$$

we have the equation

$$A\,.\,\Delta L+C\,.\,\Delta V+E\,.\,\Delta\Pi+\Delta\frac{d\rho}{dt}\cdot\frac{\varpi^2(H+\Pi\rho_0)}{uH}=0,$$

where A, C, and E are to be computed as before. This arrangement will permit the equations depending on annual parallax and radial velocity to be very simply treated together according to the method of least squares; and it will save very much labour when many stars are employed which may have been observed for both annual parallax and radial velocity.

We thus obtain the following equations depending on parallax:—

* See original article, p. 178.

First Series.

No.					Weight.
1	−8·540	ΔL + 0·041	ΔV + 29·140	Δπ = −0·058	3
3	+4·747	+0·097	+ 8·940	= +0·144	3
4	−0·196	+0·019	+ 0·873	= +0·056	3
5	+0·036	+0·002	− 0·921	= −0·017	3
6	−0·063	+0·006	− 1·796	= −0·059	3
8	+0·030	+0·008	+ 0·240	= −0·049	3
10	−0·615	+0·014	− 1·525	= −0·035	3
11	+0·001	0·000	+ 0·550	= 0·000	1
16	0·000	0·000	− 0·842	= 0·000	1
23	+0·021	0·000	− 1·186	= −0·035	3
46	−0·008	+0·006	− 0·444	= −0·089	2
47	+0·054	+0·013	+ 2·712	= −0·049	2
48	+0·106	+0·032	− 2·120	= +0·192	2
50	+0·051	+0·001	− 1·170	= −0·019	2
53	−0·345	+0·042	− 0·646	= −0·019	3
54	−0·005	+0·020	− 0·471	= −0·143	2
56	+0·356	−0·011	−19·560	= +0·010	2
57	+0·002	+0·007	− 0·520	= +0·021	2
58	−0·020	+0·012	− 0·505	= −0·059	2
60	+0·053	+0·002	− 1·192	= +0·012	2
65	+0·062	ΔL + 0·019	ΔV − 0·890	Δπ = −0·112	2

And similarly we obtain the following equations depending on radial velocity:—

Second Series.

No.					Weight.
1	−8·540	ΔL + 0·041	ΔV + 29·140	Δπ = +0·768	1
4	−0·196	+0·019	+ 0·873	= +0·019	3
5	+0·036	+0·002	− 0·921	= +0·001	3
6	−0·063	+0·006	− 1·796	= −0·015	3
8	+0.030	+0·008	+ 0·240	= −0·044	3
9	+0·100	+0·001	− 2·000	= +0·004	2
10	−0·615	+0·014	− 1·525	= −0·048	3
12	+0·014	+0·001	− 0·936	= −0·001	2
13	0·000	0·000	+ 0·536	= −0·002	1
15	−0·051	+0·003	+ 1·450	= −0·020	1
16	0·000	0·000	− 0·842	= +0·002	2
35	−0·021	+0·001	− 0·666	= 0·000	1
37	+0·007	+0·001	− 0·770	= 0·000	1
40	−0·052	ΔL 0·000	ΔV − 1·585	Δπ = +0·004	1

With reference to the weights adopted, a weight of 3 has been given to each star whose parallax is well known, or whose parallax is confirmed by its radial velocity,* and to each star whose radial velocity of the first class is confirmed by its parallax. Again, a weight of 2 has been given to each star whose unconfirmed parallax is less certain, and to each star whose unconfirmed radial velocity is of the first class. And, lastly, a weight of 1 has been given to each star whose parallax or radial velocity must be considered uncertain at present.

The following table has been drawn up according to this system:—

Weights.

	3	2	1
Parallax.	Sirius	η Cassiopeæ	β Centauri
	α Centauri	70 p. Ophiuchi	α Cygni
	Arcturus	e Eridani	
	Capella	δ Ursæ Minoris	
	Vega	μ Cassiopeæ	
	Procyon	Cephei 51 (Hev.)	
	Altair	85 Pegasi	
	Polaris	3077 Bradley	
	61 Cygni	Piazzi III. 242	
		34 Groombridge	
Radial Velocity.	Arcturus	α Orionis	Sirius
	Capella	Aldebaran	Spica
	Vega	α Cygni	Regulus
	Procyon		ϵ Pegasi
	Altair		α Cephei
			γ Aquilæ

Proceeding by the method of least squares, the first series of equations are reduced to the following:—

$$+862{\cdot}9 \quad \Delta L + 0{\cdot}797 \quad \Delta V - 1872 \quad \Delta \Pi = +10{\cdot}81,$$
$$+0{\cdot}797 \quad \Delta L + 0{\cdot}1309 \quad \Delta V + 18{\cdot}62 \quad \Delta \Pi = +0{\cdot}093,$$
$$-1872 \quad \Delta L + 18{\cdot}62 \quad \Delta V + 10015 \quad \Delta \Pi = -3{\cdot}2;$$

whence

$$\Delta L = +0{\cdot}0158,$$
$$\Delta V = +0{\cdot}380,$$
$$\Delta \Pi = +0{\cdot}00165.$$

Substituting these values of the corrections in the first

* As in the case of *Capella*, where the agreement of O. and C. in parallax may be said to be confirmed by the agreement of O. and C. in radial velocity.

series of equations, the sum of the squares of the errors is reduced from 0·121 to 0·099.

Again, proceeding by the method of least squares, the second series of equations are reduced to the following:

$$\begin{aligned}
&+76{\cdot}7 \quad \Delta L - 0{\cdot}457 \quad \Delta V - 242 \quad \Delta\Pi = -6{\cdot}32,\\
&-0{\cdot}457 \quad \Delta L + 0{\cdot}0076 \quad \Delta V + 1{\cdot}05 \quad \Delta\Pi = +0{\cdot}025,\\
&-242 \quad \Delta L + 1{\cdot}05 \quad \Delta V + 941 \quad \Delta\Pi = +23{\cdot}2;
\end{aligned}$$

whence

$$\begin{aligned}
\Delta L &= -0{\cdot}0431,\\
\Delta V &= -1{\cdot}378,\\
\Delta\Pi &= +0{\cdot}01507.
\end{aligned}$$

Substituting these values of the corrections in the second series of equations, the sum of the squares of the errors is reduced from 0·595 to 0·008.

But it is to be remarked that the results of the second series depend chiefly on *Sirius;* and when −2·1 was assumed as the mean radial velocity of that star, it was not intended that the assumption should have any great weight in the final equations, much less that it should greatly influence them.

It therefore becomes necessary to remove *Sirius* from the second series, when the remaining equations give the following:

$$\begin{aligned}
&+3{\cdot}8 \quad \Delta L - 0{\cdot}110 \quad \Delta V + 7 \quad \Delta\Pi = +0{\cdot}23,\\
&-0{\cdot}110 \quad \Delta L + 0{\cdot}0059 \quad \Delta V - 0{\cdot}14 \quad \Delta\Pi = -0{\cdot}006,\\
&+7 \quad \Delta L - 0{\cdot}14 \quad \Delta V + 93 \quad \Delta\Pi = +0{\cdot}9;
\end{aligned}$$

whence

$$\begin{aligned}
\Delta L &= +0{\cdot}051,\\
\Delta V &= +0{\cdot}063,\\
\Delta\Pi &= +0{\cdot}006.
\end{aligned}$$

Substituting these values of the corrections in the second series of equations, No. 1 being omitted, the sum of the squares of the errors are reduced from 0·005 to 0·004.

Lastly, combining both series, No. 1 being omitted from the second series, we have the equations

$$\begin{aligned}
&+866{\cdot}7 \quad \Delta L + 0{\cdot}687 \quad \Delta V - 1865 \quad \Delta\Pi = +11{\cdot}04,\\
&+0{\cdot}687 \quad \Delta L + 0{\cdot}1368 \quad \Delta V + 18{\cdot}48 \quad \Delta\Pi = +0{\cdot}087,\\
&-1865 \quad \Delta L + 18{\cdot}48 \quad \Delta V + 10108 \quad \Delta\Pi = -2{\cdot}3;
\end{aligned}$$

whence

$$\begin{aligned}
\Delta L &= +0{\cdot}0194,\\
\Delta V &= +0{\cdot}113,\\
\Delta\Pi &= +0{\cdot}00315.
\end{aligned}$$

Now the quantities to be corrected are: *

$$L = -0{\cdot}8831$$
$$M = -0{\cdot}1439$$
$$N = -0{\cdot}4466$$
$$V = +9{\cdot}943$$
$$\Pi = +0{\cdot}00665$$

and applying the corrections next above to L, V, and Π, and determining the new values of M and N as in the original article, p. 184, we have as the corrected quantities:

$L = -\ 0{\cdot}8637,$	$\log L = -\ 9{\cdot}93636$
$M = -\ 0{\cdot}1670,$	$\log M = -\ 9{\cdot}22262$
$N = -\ 0{\cdot}4756,$	$\log N = -\ 9{\cdot}67720$
$V = +10{\cdot}056,$	$\log V = +11{\cdot}00243$
$\Pi = +\ 0{\cdot}00980,$	$\log \Pi = +\ 7{\cdot}99123$

The centre, therefore, lies in the direction of the point whose co-ordinates for the year 1850 are

R.A.	10° 56′
N.P.D.	61 36

This point is very near the first point adopted in the original article; and it may be said that all the work expended on the system since it was first sketched out was required for the determination of Π, the annual parallax of the centre.

Now ΠV is the angular motion of the Sun round the centre during one year, expressed in seconds of arc; and as the new value of ΠV is $0''{\cdot}09855$, the new length of the Annus Magnus, or period of general revolution, is 13,150,000 years.

Here we must rest awhile; annual parallaxes and radial velocities have agreed in giving almost the same corrections to the former values of the constants; and the question now arises as to whether the position of the centre has not been determined with greater accuracy than the direction of the Sun's motion.† Of course the time will come when the two problems must be combined, and when the assumption of the circularity of the solar orbit must be removed; but as the combined problem will contain seven unknown corrections, namely ΔL, ΔM, ΔV, $\Delta\Lambda$, $\Delta\Pi$, $\Delta\lambda$, and $\Lambda\mu$, a large number of stars must be employed.

Lastly, putting perturbations aside, it cannot be assumed that the law of force holds good beyond a certain distance from the centre; the star-density on either side of a certain radius may vary as much as the star-density on either side of the galactic

* Original article, p. 185.

† The recent researches of Mr. Plummer (*Memoirs*, vol. xlvii. p. 327) on the motions of southern stars have at least removed the certainty assumed in the original article.

plane; and, indeed, considering the complexity of the general problem, we may be well satisfied with the definite results we have so easily obtained.

Note I.

The proper motions employed in this article were taken from the lists of Professors Main and Stone in the *Memoirs of the R.A.S.*, vols. 19, 28, and 33, excepting:—

No.	Star.	Authority.
2	α Argus	Stone, *Mem.*, vol. 42, p. 135.
3	α Centauri	Elkin „ 48, p. 14.
11	β Centauri	Stone „ 42, p. 139.
48	e Eridani	Elkin „ 48, p. 175.
49	o^2 Eridani	Gill „ „ 156.
52	ζ Toucani	Elkin „ „ 168.
55	ε Indi	„ „ „ 119.
56	Cephei 51 (Hev.)	*B.A.C.*
57	85 Pegasi	„
58	3077 Bradley	*Copernicus*, No. 22, p. 201.
59	6 B. Cygni	Argelander, *Dunsink Obs.*, Part V., p. 232.
60	Piazzi III. 242	O. Struve, *M. N.*, vol. 41, p. 36.
61	1618 Groombridge	Argelander, *Dunsink Obs.*, Part V., p. 187.
62	1830 Groombridge	Argelander, *B.A.C.*
63	21185 Lalande	Lynn.
64	9352 Lacaille	Gould, *Mem.*, vol. 48, p. 140.
65	34 Groombridge	*Nature* „ 43, p. 172.
66	21258 Lalande	Lynn, *M. N.*, vol. 33, p. 102.
67	17415 Oeltzen	„ „ 31, p. 42.
68	11677 Oeltzen	Geelmuyden, *Astr. Nach.*, No. 2287.

Note II.

The following parallaxes were employed in the above article, the means of different results being taken when possible:

No.	Star.	Parallax and Authority.
1	Sirius	0″·23, Henderson, *Mem.*, vol. 11, p. 239.
		0·27, Abbe, *M. N.*, vol. 28, p. 6.
		0·193, Von Gylden.
		0·381, Gill and Elkin, *Mem.*, vol. 48, p. 187.
		0·268, Mean.
2	Canopus	0·028, Elkin, *Mem.*, vol. 48, p. 183.
3	α Centauri	0·913, Henderson and Maclear, *Mem.*, vol. 12, p. 370.
		0·919, Maclear, *Mem.*, vol. 20, p. 98.
		0·916, Mean from zenith distances.

No.	Star.	Parallax and Authority.
		"
3	α Centauri	0·880, Moesta (at Santiago).
		0·512, Elkin, *M. N.*, vol. 41, p. 223.
		0·752, Gill and Elkin, *Mem.*, vol. 48, p. 186.
		0·765, Mean.
4	Arcturus	0·127, Peters.
		0·138, Johnson, *M. N.*, vol. 17, p. 271.
		0·132, Mean.
5	Capella	0·046, Peters.
6	Vega	0·06, ? Airy, *Mem.*, vol. 10, p. 265.
		0·155, W. Struve, Peters, and O. Struve, *M. N.*, vol. 13, p. 74.
		0·103, Peters, *Cosmos*, vol. III., p. 261.
		0·13, Brünnow.
		0·141, Johnson, *M. N.*, vol. 17, p. 271.
		0·180*, A. Hall, „ 43, p. 222.
		0·128 Mean.
8	Procyon	0·123, Auwers.
10	Altair	0·181, Struve, *Mem.*, vol. 12, p. 29.
17	Castor	0·198, Johnson, *M. N.*, vol. 17, p. 271.
23	Polaris	0·067, Peters.
		0·046, *Nature*, vol. 18, p. 669.
		0·015, L. de Ball, *Observatory*, No. 101, p. 314.
		0·043, Mean.
34	γ Draconis	0·092, *Nature*, vol. 18, p. 669.
44	ι Ursæ Maj.	0·133, Peters.
46	η Cassiopeæ	0·154, *Nature*.
47	70 p. Ophiuchi	0·16, Krüger.
48	e Eridani	0·136, Elkin, *Mem.*, vol. 48, p. 178.
49	o^2 Eridan	0·166, Gill, *Mem.*, vol. 48, p. 160.
		0·223, A. Hall, *Observatory*, October 1885.
		0·194, Mean.
50	δ Ursæ Min.	0·034, L. de Ball, *Observatory*, No. 101, p. 314
51	σ Draconis	0·255, Brünnow.
52	ζ Toucani	0·057, Elkin, *Mem.*, vol. 48, p. 171.
53	61 Cygni	0·374, Bessel corrected by Peters.
		0·349, Peters, *Cosmos*, vol. III., p. 260.
		0·553, Auwers, *M. N.*, vol. 23, p. 74.

* Corrected to 0″·134 (*Nature*, vol. 35, p. 258).

No.	Star.	Parallax and Authority.
53	61 Cygni	0″·402, Johnson, *Main's Practical and Sph. Astronomy*, p. 378.
		0·465, Ball, *M. N.*, vol. 40, p. 250.
		0·468 „ „ 41, p. 164.
		0·478*, A. Hall „ 43, p. 222.
		0·441, Mean.
		By the application of photography to the determination of parallax, Professor Pritchard has just found 0″·440, *M. N.*, vol. 47, p. 87.
54	μ Cassiopeæ	0·342, O. Struve.
55	ϵ Indi	0·215, Gill and Elkin, *Mem.*, vol. 48, p. 187.
56	Cephei 51 (Hev.)	0·027, L. de Ball, *Observatory*, No. 101, p. 314.
57	85 Pegasi	0·05, Brünnow.
58	3077 Bradley	0·205, Backlund, *M. N.*, vol. 43, p. 223.
		0·28, Von Gylden „ „
		0·07, Brünnow.
		0·185, Mean.
59	6 B Cygni	0·482, Ball, *M. N.*, vol. 43, p. 222.
60	Piazzi III. 242	0·016, Ball (from distances), *M. N.*, vol. 41, p. 40.
61	1618 Groombridge	0·322, Ball, *M. N.*, vol. 45, p. 254.
62	1830 Groombridge	0·034, O. Struve, *M. N.*, vol. 10, p. 124.
		0·226, Peters „ 14, p. 138.
		0·141, Peters and Wichmann, *M. N.*, vol. 14, p. 138.
		0·18, Wichmann and Schluter, „ 13, p. 132.
		0·145, Mean.
63	21185 Lalande	0·501, Winnecke.
64	9352 Lacaille	0·285, Gill, *Mem.*, vol. 48, p. 154.
65	34 Groombridge	0·307, Auwers, *M. N.*, vol. 28, p. 97.
66	21258 Lalande	0·262, Auwers „ 23, p. 74.
		0·260, Krüger „ „ p. 172.
		0·261, Mean.
67	17415 Oeltzen	0·247, Krüger. *M. N.*, vol. 23, p. 172.
68	11677 Oeltzen	0·270, Geelmuyden from R.A.
		0·242 „ „ Decl.
		0·256, Mean, *Astr. Nach.*, No. 2287.
11	β Centauri	Gill found a small negative parallax; hence the parallax must be very small.
16	α Cygni	In Herschel's *Outlines of Astronomy* (sixth edition) p. 593, the parallax is similarly taken to be very small.

* Corrected to 0″·270 (*Nature*, vol. 35, p. 258).

Note III.

The following radial velocities were adopted from the observations made at Greenwich :—

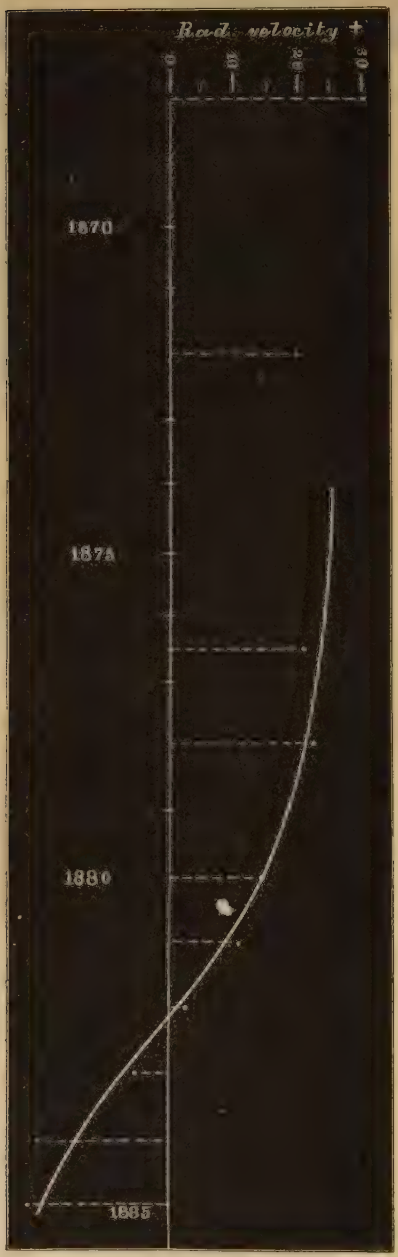
First Class.			Second Class.		
No.	Star.	Miles per Sec.	No.	Star.	Miles per Sec.
4	α Boötis	−46·0	13	α Virginis	−11·9
5	α Aurigæ	+26·0	15	α Leonis	+10·1
6	α Lyræ	−36·1	18	ε Ursæ Maj.	+11·8
7	β Orionis	+19·1	19	α Persei	−27·7
8	α Canis Min.	+15·5	20	β Tauri	−14·3
9	α Orionis	+26·9	22	β Ceti	−33·5
10	α Aquilæ	−24·9	24	α Arietis	−14·2
12	α Tauri	+32·0	25	γ Cassiop.	−19·3
14	β Gemin.	−31·8	26	γ Leonis	−26·2
16	α Cygni	−34·1	27	ζ Ursæ Maj.	+19·3
17	α Gemin.	+17·8	28	α Ophiuchi	−10·9
21	α Androm.	−28·2	30	γ Cygni	−13·5
29	α Coronæ	+20·7	31	β Cassiop.	− 1·2
36	α Pegasi	−25·5	32	β Ursæ Maj.	+22·9
			33	γ Ursæ Maj.	+17·5
			34	γ Draconis	− 7·2
			35	ε Pegasi	−14·3
			37	α Cephei	−41·8
			38	γ Pegasi	−23·4
			39	γ Virginis	+25·0
			40	γ Aquilæ	−24·3
			41	δ Cygni	−14·7
			42	β Cygni	−14·3
			43	ζ Aquilæ	−23·0
			45	δ Androm.	−40·6

Note IV.

The radial velocity of *Sirius* and its curve of variation have been deduced from the following observations made at Greenwich, and given in the *Monthly Notices*, vol. xlv., p. 283:

Opposition of	Miles per Sec.	Opposition of	Miles per Sec.
1875–76 } 1876–77 }	+21·1	1881–82	+ 2·1
1877–78	+23·0	1882–83	− 4·7
1879–80	+15·1	1883–84	−19·4
1880–81	+11·3	1884–85	−21·5

But Dr. Huggins found +29·4 for about the opposition of 1868, and +20 for about the opposition of 1872, so that we have the following curve:


Rad. velocity +
1870
1875
1880
1885

Assuming a mean value of −6 at the opposition of 1882–83, or early in the year 1883, and dividing by 2·9, we have −2·1 as the mean radial velocity of *Sirius*.

Jamaica: 1887, *March* 26.

Observations of Comets and of Sappho 80 [illegible].

By G. L. Tupman.

Revised Geocentric places of Comet 1884 *III.* (*Wolf*).
(*Monthly Notices R.A.S.*, xlv. 403.)

1884–5.	Greenwich Mean Time. h m s	App. R.A. h m s	App. Decl. ° ′ ″	Log. Δ.	Star.
Sept. 24	10 38 0	21 17 23·36	+20 36 20·9	9·9036	1
25	9 46 4	21 17 58·81	+20 9 42·6	9·9030	2
27	10 45 50	21 19 22·76	+19 12 37·4	9·9019	3
Oct. 4	9 17 52	21 25 33·82	+15 51 52·0	9·9014	4
	9 59 47	21 25 35·90	+15 51 1·1	9·9014	4
	10 23 34	21 25 36·89	+15 50 35·6	9·9014	4
13	11 29 16	21 36 55·31	+11 24 18·8	9·9072	5
22	9 30 22	21 51 21·09	+7 12 33·6	9·9200	6
26	10 4 32	21 58 49·15	+5 26 35·6	9·9277	7
Nov. 7	10 27 53	22 23 57·02	+0 49 41·1	9·9566	8
8	9 40 20	22 26 7·26	+0 30 21·7	9·9593	9
18	9 41 0	22 49 39·28	−2 22 34·2	9·9890	10
19	6 19 34	22 51 45·38	−2 35 6·7	9·9918	10
20	9 28 34	22 54 31·77	−2 50 55·4	9·9954	11
21	5 56 32	22 56 37·57	−3 2 30·8	9·9981	12
Dec. 9	6 34 15	23 42 25·41	−5 45 27·5	0·0589	13
15	6 1 59	23 57 52·08	−6 9 13·4	0·0796	14
Jan. 7	6 48 36	0 56 56·32	−5 53 8·2	0·1618	15
	6 48 36	0 56 56·30	−5 53 10·6	0·1618	16
Feb. 5	6 56 43	2 8 27·96	−3 9 17·7	0·2538	17

The times have not been corrected for aberration.

Comet 1885 *II.* (*Brooks*).
(*Monthly Notices*, xlvi. 123.)

1885.	Greenwich Mean Time. h m s	App. R.A. h m s	Lfp.	App. Decl. ° ′ ″	Lfp.	Star.
Sept. 6	9 54 15	14 3 47·40	+8·719	+38 24 18·7	+9·847	18
9	9 29 21	14 21 28·30	+8·730	+39 38 44·1	+9·808	19
11	9 28 15	14 33 55·00	+8·736	+40 23 9·7	+9·795	20
13	9 42 43	14 46 53·56	+8·738	+41 3 29·9	+9·806	21
	9 42 43	14 46 53·53	+8·738	+41 3 25·4	+9·806	22

Some small errors were discovered in the reductions.

Comet 1886 I. (*Fabry*).

		✱ − ✱ Δα	Δδ	Comp.	✱ α	Par.	✱ δ	Par.	Star.
1885.	h m s	m s	′ ″		h m s		° ′ ″		
Dec. 7	10 26 50	−0 28·70	+ 1 52·0	9	0 24 59·91	+[8·513]	+20 52 29·8	+[9·762]	23
10	10 5 1	−1 28·31	− 1 1·1	14	0 18 36·78	+[8·505]	+20 48 19·8	+[9·761]	24
27	9 43 17	−0 6·58	+ 0 22·8	11	23 50 8·68	+[8·604]	+20 43 13·1	+[9·803]	25
1886.						s			
Jan. 26	6 45 32	−2 30·07	+ 0 6·6	7	23 26 54·35	+·18	+22 51 22·2	+ 2·8	26
28	6 49 48	−0 40·61	+ 0 9·3	10	23 26 11·05	+·19	+23 7 14·3	+ 2·9	27
30	6 32 34	+0 10·54	− 0 3·5	9	23 25 32·69	+·18	+23 24 5·8	+ 2·8	28
31	7 14 34	−0 45·42	+ 4 7·7	8	23 25 13·99	+·21	+23 33 7·1	+ 2·2	29
Feb. 2	6 30 41	−1 4·01	− 5 8·7	8	23 24 41·08	+·20	+23 51 15·0	+ 3·0	30
10	7 7 16	+0 24·67	− 3 20·3	6	23 22 58·83	+·24	+25 14 45·2	+ 3·4	31
25	7 32 57	−0 56·58	− 2 25·9	8	23 21 0·09	+·27	+28 33 59·1	+ 4·1	32
26	7 0 43	−1 41·15	− 4 34·1	6	23 20 52·23	+·27	+28 48 50·4	+ 4·0	33
27	6 52 45	−1 0·84	−11 33·5	3	23 20 45·29	+·28	+29 4 18·3	+ 4·0	34
	6 56 34	+2 18·31	+ 1 22·4	1	23 20 44·71	+·28	+29 4 9·6	+ 4·0	35
Mar. 3	7 1 3	+1 21·62	+ 3 27·3	6	23 20 15·99	+·29	+30 8 33·2	+ 4·2	36
8	7 11 20	+0 18·48	−11 40·3	6	23 19 33·73	+·30	+31 33 47·9	+ 4·7	37
9	7 5 34	−0 19·29	+ 0 46·6	11	23 19 24·35	+·30	+31 51 19·1	+ 4·7	38
11	7 14 57	+0 34·94	−10 30·5	6	23 19 4·62	+·30	+32 27 6·5	+ 5·0	39
31	7 53 9	+0 33·00	+ 0 30·8	5	23 18 3·43	+·34	+38 22 52·8	+ 8·5	40
Apr. 6	8 17 53	+2 7·03	− 4 18·8	9	23 23 3·89	+·35	+39 41 26·7	+10·7	41

December 23.—Comet very much brighter; fully 2′ diameter.
December 27.—Comet bright; nucleus sub-stellar.
January 26.—Very bright, nearly 6 mag. More than 3′, perhaps 5′ diameter; with bright central condensation, not stellar. Ring Micrometer used Dec. 7, to Jan. 30; Crossed Bars afterwards.
March 9.—Faint; very low. March 31.—Bright although so very low.
April 6.—Bright; only $5\frac{1}{2}°$ above the horizon. April 9. See *Ast. Nach.* 2723.

Comet 1886 *II.* (*Barnard.*)

	G.M.T.	Δα	−✶ Δδ	Comp.	✶α	Par.	✶δ	Par.	Star.
1885.	h m s	m s	′ ″		h m s		° ′ ″	″	
Dec. 27	10 7 38	+0 59·22	+10 56·3	7	3 22 31·44	+·07	+ 7 31 54·2	+3·8	42
1886.									
Jan. 28	7 11 5	+0 14·48	+ 0 20·2	9	2 21 21·62	+·07	+13 27 33·9	+2·8	43
Feb. 1	6 54 42	−0 3·41	+ 0 45·8	11	2 16 28·49	+·08	+14 19 8·1	+3·2	44
2	7 2 12	−1 11·48	+14 1·2	5	2 15 20·42	+·09	+14 32 23·5	+3·2	45
26	7 25 36	+1 0·58	− 4 28·5	8	1 57 43·99	+·19	+20 19 54·9	+3·1	46
Mar. 3	7 15 22	+0 6·97	+ 7 57·1	7	1 55 53·04	+·20	+21 41 10·3	+3·2	47
8	7 29 43	−0 43·83	+15 57·9	5	1 54 27·41	+·22	+23 6 28·9	+3·3	48
9	7 21 22	−1 0·56	− 8 14·4	6	1 54 12·17	+·22	+23 23 57·4	+3·3	49
11	7 28 48	−1 0·38	+ 6 17·8	6	1 53 45·47	+·23	+23 59 44·7	+3·3	50
Apr. 3	9 0 56	+0 42·22	− 2 55·9	8	1 49 52·44	+·25	+31 48 53·1	+4·8	51
6	8 39 42	−0 16·87	− 3 35·2	9	1 49 8·62	+·26	+32 57 43·8	+4·9	52
8	9 20 14	+1 31·02	−10 37·3	7	1 48 33·99	+·23	+33 45 17·9	+5·3	53
11	8 50 49	+1 3·82	+12 34·8	9	1 47 33·84	+·26	+34 55 57·8	+5·4	54
15	9 5 8	−2 21·39	− 3 7·7	8	1 45 51·57	+·25	+36 30 48·0	+5·9	55

December 27.—Comet pretty bright; not so bright as Fabry's; diam. 90″; nucleus sub-stellar, admitting of accurate observation. Ring Micrometer used Dec. 27, and Jan. 28; Crossed Bars afterwards.

January 28.—Diameter 90″. Coma extended in direction 120° or 130°.

February 1.—Diameter 90″. Stellar nucleus (?) of $9\frac{1}{2}$ or 10 mag.

March 9.—Comet large, more than 2′ diam., perhaps 3′; very low.

April 3.—Very bright, although very low, may be 5 mag.; at least 3′ diameter.

April 15.—Comet faint owing to ☾ and haze.

Comet 1886 *V.* (*Brooks* 1.)

	G.M.T.	Δα	Δδ	Comp.	α	Par.	δ	Par.	Star.
1886.	h m s	m s	′ ″		h m s		° ′ ″		
May 6	10 27 27	−3 18·48	− 7 6·8	9	1 27 21·84	+·01	+57 16 30·5	+6·4	56
15	9 48 27	−0 37·07	− 4 30·1	10	2 19 35·61	+·11	+49 58 53·3	+6·9	57
18	9 40 18	+0 52·56	− 5 19·4	6	2 34 30·13	+·12	+46 59 22·0	+6·9	58
	9 49 34	+0 32·03	+ 7 4·4	5	2 34 31·46	+·12	+46 58 58·0	+6·9	59
	9 49 34	+0 21·26	+ 6 57·0	5	2 34 31·59	+·12	+46 58 57·7	+6·9	60
20	10 24 35	−0 5·17	+11 42·8	7	2 43 24·11	+·05	+44 53 23·6	+7·1	61

May 6.—Comet is about 9 mag. 2′ diameter, with central condensation but no visible nucleus ($4\frac{1}{2}$-inch refractor).

May 20.—Very near the horizon, must be 5 or 6 mag.

Comet 1886 *IX.* (*Barnard-Hartwig.*)

	G.M.T.	☄−✶ Δα	Δδ	Comp.	☄α	Par.	☄δ	Par.	Star.
1886.	h m s	m s	′ ″		h m s	s	° ′ ″	″	
Dec. 19	5 31 27	−0 14·77	+5 40·2	13	18 17 3·15	+·33	+12 4 17·1	+5·8	62
23	5 23 15	+1 13·38	+3 30·0	6	18 46 5·93	+·29	+ 9 26 41·6	+5·4	63
	5 33 49	−1 56·16	−4 58·4	5	18 46 9·50	+·30	+ 9 26 23·6	+5·4	64
25	5 32 43	+0 50·08	−0 44·1	17	18 58 53·69	+·28	+ 8 7 9·9	+5·2	65
	5 34 0	−0 7·71	−0 48·3	17	18 58 54·03	+·28	+ 8 7 3·9	+5·2	66
27	5 25 16	−0 34·42	+5 42·0	13	19 10 32·71	+·27	+ 6 49 14·1	+5·1	67
30	5 56 24	+0 23·84	+7 47·1	9	19 26 25·12	+·26	+ 4 54 52·5	+4·9	68
31	5 37 26	−0 29·88	−5 38·9	10	19 31 11·90	+·25	+ 4 18 45·9	+4·9	69
1887.									
Jan. 5	5 35 31	−0 13·08	+4 34·94	15	19 52 45·40	+·23	+ 1 26 24·3	+4·6	70

December 18.—Comet very bright, circular, nucleus 15″ to 20″, diminishing to a stellar object as clouds pass over it. Coma extensive, perhaps 10′ diam. Tail 40′, perhaps 60′.

December 19.—Nucleus stellar, 7 mag. Coma 20^s in R.A. Air very thick, foggy.

December 20.—☄=ε Aquilæ exactly. Tail 7° towards 110 Herculis.

December 25.—Nucleus stellar, small.

December 30.—Nucleus not so distinct. December 31.—Still stellar.

Comet 1887. . . . (*Barnard, May* 12).

1887.	G.M.T. h m s	Δα m s	∂−✶ Δδ ′ ″	Comp.	∂α h m s	Par. s	∂δ ° ′ ″	Par. ″	Star.
June 12	11 38 22	−1 46·24	+ 3 53·0	11, 6	16 11 0·02	+·20	−8 43 40·3	+19·1	71
15	11 42 49	+1 16·66		13	16 17 43·99	+·24			72
	11 42 49		− 2 14·5	5			−6 29 54·0	+18·5	73
17	11 51 47	−0 35·36	+ 7 21·8	7	16 22 15·21	+·28	−5 4 15·2	+18·0	74
19	11 53 55	−1 20·24	−10 10·1	8	16 26 43·78	+·19	−3 43 12·5	+18·0	75
22	11 5 45	+0 44·24	+ 1 40·7	4, 2	16 33 29·14	+·13	−1 48 14·6	+17·2	76

Comet faint and small, condensed excentrically, admitting of pretty accurate observation (18-inch reflector). 11 or 12 mag. Ring Micrometer used, except on June 12.

Sappho (80)

1887	G.M.T. h m s	Δα m s	Δδ ′ ″	Comp.	(80)α h m s	Par. s	(80)δ ° ′ ″	Par. ″	Star.
Jan. 5	11 1 19	−0 49·77	− 4 42·5	10	7 8 13·90	+·08	+8 50 44·3	+ 4·27	77

Observed with the 18-inch reflector and bars carefully oriented.
The small corrections have been applied to all the above observations.

Mean Places of the Comparison Stars.

		1884·0.			Mer. Obs.	Reductions to App. Place.	
		h m s	° ′ ″			s	″
1	D.M. + 20°·4902	21 18 32·58	+ 20 29 10·6		Harrow 4		
5	L.L. 42432	21 40 16·20	+ 11 20 44·9		,, 4		
6	Lamont 6182	21 48 21·87	+ 7 15 42·3		Strassburg 2		
		21·90		41·8	Harrow 3		
7	{P XXI. 390 / Santini 1537}	21 59 52·37	+ 5 24 9·1		,, 3		
8	Lamont 8848	22 22 57·84	+ 0 44 12·4		,, 2		
9	L.L. 44036	22 26 45·64	+ 0 30 26·2		,, 2		
10	Lamont 9034	22 51 6·96	− 2 28 20·6		,, 4		
11	W.B. 1110	22 64 37·81	− 2 50 10·8		,, 3, 4		
12	L.L. 45064	22 56 46·10	− 3 5 14·8		,, 3, 4		
13	W.B. 821	23 41 54·84	− 5 53 1·9		Strassburg 2		
14	W.B. 1152	23 57 20·83	− 6 6 24·8		,, 2		
		20·84		23·5	Harrow 4		
		1885·0.					
15	W.B. 998	0 58 34·85	− 5 55 17·1		Harrow 2, 3		
16	W.B. 1003	0 58 47·84	− 5 56 19·2		,, 3		
17	Schj. 649	2 7 44·27	− 3 10 35·3		,, 2		
		43·95		38·5	Strassburg 1		
18	W.B. 77, 78	14 5 39·86	+ 38 32 37·9		Harrow 3		
19	W.B. 451	14 22 11·57	+ 39 38 47·3		,, 3		
20	W.B. 681–2	14 33 33·27	+ 40 31 8·6		,, 6		
21	W.B. 960	14 45 39·14	+ 40 59 50·5		,, 5		
22	W.B. 973	14 47 3·36	+ 41 10 21·1		,, 5		
23	D.M. + 20°, 52	0 25 25·17	+ 20 50 12·8		,, 2	+ 3·44	+ 25·0
24	D.M. + 20°, 39	0 20 1·80	+ 20 48 55·7		,, 3	+ 3·36	+ 25·2
25	D.M. + 20°, 5397	23 50 12·36	+ 20 42 24·8		,, 4	+ 2·90	+ 25·4
		1886·0.					
26	D.M. + 22°, 4865	23 29 25·05	+ 22 51 12·6		Harrow 2	− 0·63	+ 3·0
27	D.M. + 22°, 4856	23 26 52·20	+ 23 7 4·1		B.B. VI. 1	− 0·66	+ 2·7
		52·42		0·3	Harrow 1		
28	D.M. + 23°, 4755	23 25 22·83	+ 23 24 6·8		,, 3	− 0·68	+ 2·5
29	L.L. 46081	23 26 0·09	+ 23 28 57 0		,, 2	− 0·68	+ 2·4
30	D.M. + 23°, 4756	23 25 45·79	+ 23 56 21·5		,, 2	− 0·70	+ 2·2
31	W.B. 445–6	23 22 34·92	+ 25 18 4·4		,, 4, 3	− 0·76	+ 1·1
32	W.B. 423	23 21 56·67	+ 28 36 25·0		,, 2	− 0·81	− 0·9
33	L.L. 45957	23 22 34·19	+ 28 53 25·6		,, 3	− 0·81	− 1·1

				1885·0.			Mer. Obs.	Reductions to App. Place.	
		h	m	s	°	′	″	s	″
34	W.B. 421	23	21	46·94	+29	15	53·0	„ 2	−0·81	− 1·2
35	L.L. 45821	23	18	27·22	+29	2	48·5	Armagh$_2$ 5, 8	−0·82	− 1·3
36	L.L. 45839	23	18	55·18	+30	5	7·8	Harrow 2	−0·81	− 1·9
37	L.L. 45845	23	19	16·05	+31	45	31·0	„ 2	−0·80	− 2·8
38	L.L. 45857	23	19	44·43	+31	50	34·6	Radcliffe 3	−0·79	− 2·8
				44·60			36·0	Armagh 1, 5		
				44·41			33·9	Harrow 1		
39	W.B. 346	23	18	30·47	+32	37	40·1	„ 2	−0·79	− 3·1
40	W.B. 328	23	17	31·11	+38	22	28·3	„ 3, 4	−0·68	− 6·3
41	W.B. 402	23	20	57·38	+39	45	52·6	„ 2	−0·52	− 7·1
					1885·0.					
42	W.B. 344	3	21	28·21	+ 7	20	52·5	Harrow 3, 4	+4·01	+ 5·4
					1886·0.					
43	W.B. 311	2	21	6·95	+13	27	18·9	Harrow 2	+0·19	− 5·2
44	D.M. + 14°, 386	2	16	31·79	+14	18	27·3	„ 3, 2	+0·11	− 5·0
45	D.M. + 14°, 386	2	16	31·79	+14	18	27·3	„ 3, 2	+0·11	− 5·0
46	D.M. + 20°, 327	1	56	43·73	+20	24	27·8	„ 3, 2	−0·32	− 4·4
47	W.B. 1290	1	55	46·45	+21	33	17·7	„ 2	−0·38	− 4·5
48	L.L. 3715	1	55	11·69	+22	50	34·6	Armagh$_2$ 2, 3	−0·44	− 4·6
				11·67			36·8	Harrow 2		
49	D.M. + 23°, 271	1	55	13·17	+23	32	16·4	„ 2	−0·44	− 4·6
50	W.B. 1263	1	54	46·31	+23	53	31·6	Armagh$_2$ 2, 3	−0·46	− 4·7
51	W.B. 1095	1	49	10·83	+31	51	54·8	Harrow 3, 2	−0·61	− 5·8
52	W.B. 1106	1	49	26·10	+33	1	25·0	„ 2	−0·61	− 6·0
53	W.B. 1047	1	47	3·58	+33	56	1·4	„ 3	−0·61	− 6·2
54	L.L. 3415	1	46	30·62	+34	43	29·5	„ 2	−0·60	− 6·5
55	L.L. 3476	1	48	13·57	+36	34	0·6	Glasgow 3	−0·59	− 6·8
				13·52			2·6	Armagh$_2$ 1		
				13·55			3·8	Harrow 2		
56	B.A.C. 482	1	30	40·76	+57	23	47·0	Radcliffe 4, 3	−0·46	− 9·7
				40·87			46·3	Gr. 1860 4, 2		
				40·66			47·5	Kr. Z. 331 1		
57	66 Androm.	2	20	13·03	+50	3	33·4	Gr. 1864 3	−0·35	−10·0
58	L.L. 4902	2	33	37·88	+47	4	51·5	Harrow 3	−0·31	−10·1
59	D.M. + 46°, 609	2	33	59·73	+46	52	3·7	„ 3	−0·30	−10·1
60	D.M. + 46°, 610	2	34	10·63	+46	52	10·8	„ 3	−0·30	−10·1
61	L.L. 5203	2	43	29·52	+44	41	51·3	„ 5	−0·25	−10·5

		1886·0.		Mer. Obs.	Reductions to App. Place.
		h m s	° ′ ″		s ″
62	L.L. 33895	18 17 17·07	+ 11 58 26·3	„ 2, 3	+ 0·85 + 10·6
63	D.M. + 9°, 3885	18 44 51·59	+ 9 22 59·7	„ 2	+ 0·96 + 11·9
64	W.B. 1186	18 48 4·62	+ 9 31 10·0	Glasgow 3, 4	+ 0·96 + 12·2
		4·72	9·7	Armagh$_2$ 7	
65	L.L. 35624	18 58 2·62	+ 8 7 39·0	Harrow 3	+ 1·03 + 12·4
		2·53	40·3	Glasgow 2, 3	
66	W.B. 1474	18 59 0·71	+ 8 7 39·7	Harrow 3	+ 1·03 + 12·5
67	Lamont 4063	19 11 6·04	+ 6 43 19·2	„ 2	+ 1·09 + 12·9
68	W.B. 405	19 26 0·11	+ 4 46 52·2	„ 4	+ 1·17 + 13·2
69	D.M. + 4°, 4168	19 31 40·61	+ 4 24 11·4	„ 3	+ 1·17 + 13·4
		1887·0.			
70	W.B. 1286	19 53 0·23	+ 1 21 45·3	Glasgow 2, 3	− 1·75 + 4·1
71	L.L. 29697	16 12 44·19	− 8 47 36·0	Harrow 3	+ 2·07 + 2·7
72	W.B. 272	16 16 25·26	− 6 35 49·9	„ 3	+ 2·07 + 3·4
73	S.D. − 6°, 4425	16 18 19·29	− 6 27 43·0	„ 4	+ 2·07 + 3·5
74	L.L. 29970	16 22 48·50	− 5 11 40·9	„ 3	+ 2·07 + 3·9
75	L.L. 30118	16 28 1·95	− 3 33 5·9	„ 5	+ 2·07 + 3·5
76	Lamont 5231	16 32 42·83	− 1 50 0·5	„ 3	+ 2·07 + 5·2
77	Anonymous 9·2 mag.	7 9 2·80	+ 8 55 36·5	Cambridge 4	+ 0·87 − 9·6

Observations of the Planet Sappho made at the Cambridge Observatory with the Northumberland Equatorial and Square-Bar Micrometer.

(*Communicated by Prof. J. C. Adams.*)

Greenwich Mean Time 1887.	R.A.	Decl.	Number of Comparisons.	Name of Comparison Star.
	h m s	° ′ ″		
Jan. 12·42844	7 0 35·22	8 59 37·46	10	Arg. + 8°—1651
	6 52 33·75	9 17 24·50		„ + 9—1352
„ 20·40714	6 52 33·89	9 17 27·27	8	„ + 9—1353
	6 52 33·97	9 17 26·24		„ + 9—1396
Jan. 25·42877	6 48 10·20	9 32 1·94	10	„ + 9—1314
„ 26·38245	6 47 24·51	9 35 4·10	10	„ + 9—1314
	6 47 24·38	9 35 2·90		„ + 9—1330
Jan. 31·36133	6 43 49·78	9 51 44·70	12	„ + 9—1297
Feb. 1·42203	6 43 9·62	9 55 37·46	10	„ + 9—1276
Feb. 2·38874	6 42 34·78	9 59 6·72	10	„ + 9—1276

Observations not corrected for Aberration and Parallax.

Places of some Stars which have been compared with the Planet Sappho at the Cambridge Observatory and elsewhere; deduced from observations with the Cambridge Transit Circle.

Arg. No.	Mag.	Mean R.A. Jan. 1, 1887.	Mean N.P.D. Jan. 1, 1887.	Number of Observations
		h m s	° ′ ″	
Arg. +9°—1276	7-5	6 39 13·314	80 7 5·05	5
„ +9—1297	8-5	6 43 22·912	80 15 1·17	5
„ +9—1314	7-7	6 45 23·784	80 25 38·70	5
„ +9—1330	8-9	6 48 19·610	80 22 25·73	5
„ +9—1352	9	6 50 56·975	80 46 15·67	4
„ +9—1353	9	6 50 58·533	80 50 54·87	3
„ +9—1394	7-9	6 57 2·624	80 48 39·80	3
„ +8—1626	9-4	6 57 3·940	81 3 53·64	2
„ +9—1396 / B.A.C. 2304	6	6 57 7·239	80 41 54·64	5
Arg. +8—1651	8-4	7 0 33·209	81 6 32·65	5
„ +9—1447	8-3	7 4 27·586	81 1 56·56	3
„ +8—1697	8-7	7 7 8·651	81 15 13·51	3
„ +8—1709	9-4	7 9 2·798	81 4 23·47	4
„ +8—1752	9	7 17 30·215	81 12 19·88	3
„ +9—1541	8-9	7 19 20·611	80 59 32·69	3
„ +9—1569	9	7 22 54·534	80 59 24·45	3
„ +8—1801	8-5	7 26 38·076	81 6 13·69	3

On the Orbit of Comet II. 1883. By Lieut.-Gen. J. F. Tennant, R.E., F.R.S.

I recently sent a note to the Secretaries acknowledging that Mr. Bryant had pointed out two mistakes in the comparison of the places of this comet with my Ephemeris. I was, however, on looking over his paper, very doubtful as to the mode in which his normal places were obtained, and have examined and repeated my calculations.

Believing that Mr. Bryant had verified all my reductions, I assumed these, with the corrections he pointed out, to be accurate, and proceeded to interpolate the errors of the Ephemeris so as to get the most probable values at the same dates as before. The errors changed a good deal, and on proceeding to compute a parabolic orbit I found that the following (which is close to Mr. Tebbutt's) represented my new places almost exactly:—

Perihelion Passage, 1883, Dec. 25·30221.

Equinox of Jan. 1, 1884 $\begin{cases} \pi = 43^\circ\ 12'\ 24''.79 \text{ or } \omega = 138^\circ\ 45'\ 03''.29, \\ \Omega = 264\ 27\ 21.50, \\ L = 114\ 59\ 03.71, \end{cases}$

$\log. q = 9.4919541.$

This result was so different from Mr. Bryant's, that, having ascertained that he had not verified all my reductions, I once more repeated them, and finding only one sensible change I proceeded to deduce fresh normal places. These were—

		R.A.	Dec.
For 1884, Jan.	17·0	$340^\circ\ 41'\ 23''.07 \pm 2''.31$	$-41^\circ\ 32'\ 52''.64 \pm 1''.10$,
	23·5	349 09 20·11 ± 1·98	−41 58 18·51 ± 2·34,
	30·0	355 01 27·03 ± 3·63	−41 51 55·78 ± 0·88.

Longitude.

or for 1884, Jan.	17·0	$325^\circ\ 11'\ 34''.2 \pm 1''.89$	$-30^\circ\ 39'\ 36''.5 \pm 1''.24$,
	23·5	331 36 34·5 ± 2·05	−33 55 15·3 ± 2·18,
	30·0	336 21 03·6 ± 1·83	−35 54 41·2 ± 2·31,

all being referred to the equinox of Jan. 1, 1884.

The corresponding places, computed from the elements I have given above, are :—

For 1884, Jan.	17·0	$325^\circ\ 11'\ 35''.1$	$-30^\circ\ 39'\ 36''.6$,
	23·5	331 36 33·2	−33 55 14·1,
	30·0	336 21 03·9	−35 54 41·5 ;

that is, the elements represent the normal places far within their probable errors. It would seem, then, that the difference of the results at which Mr. Bryant and I have finally arrived is due to the modes in which we have respectively deduced our normal places from observation.

Ephemerides of the Satellites of Saturn, 1887–88. By A. Marth.

In the following ephemerides the five inner satellites are assumed to move in circular orbits in the plane of the ring, the ascending node N and inclination J of which, in reference to the plane of the Earth's equator, are assumed to be

For 1888·0 $N = 126°·6279$ $J = 6°·9930$.

In the tables P denotes the position-angle of the minor axis of the ring, L + 180° the planetocentric longitude of the Earth referred to the plane of the ring, Λ + 180° that of the Sun, or Λ − L the difference between the two. The apparent equatorial diameter of the ball and the diameter of the outer rim of the ring depend still on Bessel's determinations. The assumed proportion of the polar axis of the ball to the equatorial diameter is 0·900.

In the tables for the five satellites a and b are the semi-axes of the apparent orbits, l–L the longitudes of the satellites in their orbits reckoned from the points which are in superior conjunction with the planet's centre or in opposition to the Earth in longitude. By adding to $l - L$ the value of L from the first table, the longitudes l are found. These longitudes, which are the orbital longitudes from the ascending node added to the right ascension N of the ascending node, reckoned from the point of the true equinox, are corrected for the equation of light, and depend on the following assumed values, which refer to the time when the light arrives at the distance [0·950]:—

Greenwich Noon.	Mimas. l_1	Enceladus. l_2	Tethys. l_3	Dione. l_4	Rhea. l_5
1887, Oct. 15	218°·950	190°·745	156°·156	340°·497	0°·883
Nov. 14	158·743	152·699	117·100	326·547	231·586
Dec. 14	98·538	114·653	78·045	312·597	102·289
1888, Jan. 13	38·334	76·607	38·989	298·647	332·992
Feb. 12	338·131	38·561	359·934	284·697	203·695
Mar. 13	277·989	0·515	320·878	270·747	74·398
Apr. 12	217·728	322·468	281·822	256·796	305·100
May 12	157·528	284·422	242·767	242·846	175·803

The values of P, a, b and $l - L$ are to be interpolated directly for the times for which the apparent positions of the satellites are required, and the rectangular co-ordinates x and y, reckoned parallel to the axes of the ring, and expressed in seconds of arc, or, if polar co-ordinates are wanted, the position-angles p and distances s of the satellites in reference to the planet's centre, are then found by means of the formulæ:

$$s \sin (p - P) = x = a \sin (l - L),$$
$$s \cos (p - P) = y = b \cos (l - L).$$

Greenwich Noon.	P	L	Latitude of Earth above plane of Ring.	Latitude of Sun above plane of Ring.	A−L	log ν*
1887	°	°	°	°	°	
Oct. 15	352·607	130·363	−18·869	−21·024	−6·099	9·983285
20	·612	130·640	18·776	20·970	6·187	·987105
25	·616	130·875	18·699	20·916	6·234	·991009
30	·619	131·068	18·638	20·861	6·238	·994972
Nov. 4	352·622	131·218	−18·593	−20·806	−6·199	9·998969
9	·624	131·323	18·565	20·751	6·116	0·002971
14	·625	131·383	18·554	20·696	5·988	·006949
19	·625	131·397	18·562	20·641	5·814	·010869
24	·623	131·365	18·587	20·585	5·593	·014694
29	·621	131·287	18·629	20·530	5·327	·018391
Dec. 4	352·618	131·164	−18·688	−20·474	−5·017	0·021924
9	·614	130·998	18·763	20·418	4·664	·025260
14	·609	130·791	18·854	20·361	4·269	·028362
19	·604	130·545	18·959	20·305	3·835	·031193
24	·598	130·262	19·077	20·248	3·365	·033720
29	·591	129·947	19·206	20·191	2·863	·035914
1888						
Jan. 3	352·584	129·605	−19·344	−20·134	−2·335	0·037749
8	·577	129·239	19·489	20·077	1·783	·039204
13	·571	128·855	19·640	20·020	1·212	·040256
18	·564	128·458	19·794	19·962	0·629	·040891
23	·558	128·054	19·948	19·904	−0·039	·041101
28	·552	127·649	20·102	19·846	+0·552	·040886
Feb. 2	352·546	127·249	−20·252	−19·788	+1·137	0·040250
7	·541	126·859	20·396	19·730	1·712	·039201

* Log ν = 0·950 − log Δ, the *Naut. Alm.* values of the distances Δ being altered to take the equation of light into account.—In deducing from the measurements of the satellites' positions the dimensions of their orbits, and consequently the mass of *Saturn*, the effect of the existing uncertainty concerning the correctness of the planet's tabular distances from the Sun and from the Earth must not be lost sight of. The difference between the distances derived from Bouvard's and from Le Verrier's tables of *Saturn* for the opposition of 1879 (the only one, so far as I know, for which computations from both tables are available) corresponds to a difference of about 3 units in the deduced proportion of the mass of the Sun to that of *Saturn*, and in the next preceding oppositions the difference has probably been larger. As the observed positions of the planet show that in 1879 Le Verrier's tables give the heliocentric longitudes of *Saturn* about 12″·7 too great, while Bouvard's give them about 8″·9 too small, the differences of the tabular values of the radius vector raise a question at present beset with doubt. If heliocentric places of *Saturn*, computed accurately from Le Verrier's tables for the years preceding 1879, exist anywhere, the publication of at least part of them, be it even of only one place for each opposition, would be of service and would be appreciated.

Greenwich Noon.	P	L	Latitude of Earth above plane of Ring.	Latitude of Sun above plane of Ring.	Δ−L	log ρ*
1888	°	°	°	°	°	
Feb. 12	·537	126·485	20·534	19·671	2·271	·037751
17	·533	126·133	20·662	19·613	2·808	·035918
22	·530	125·808	20·780	19·554	3·318	·033728
27	·527	125·514	20·886	19·495	3·797	·031208
Mar. 3	352·525	125·255	−20·979	−19·435	+4·241	0·028389
8	·523	125·034	21·058	19·376	4·646	·025301
13	·522	124·854	21·122	19·316	5·010	·021977
18	·521	124·717	21·172	19·257	5·331	·018452
23	·520	124·625	21·206	19·197	5·607	·014764
28	·520	124·579	21·225	19·137	5·837	·010947
Apr. 2	352·520	124·579	−21·228	−19·076	+6·021	0·007034
7	·520	124·625	21·216	19·016	6·158	0·003056
12	·521	124·716	21·188	18·955	6·250	9·999044
17	·521	124·853	21·145	18·894	6·295	·995030
22	·522	125·034	21·087	18·833	6·297	·991043
27	·524	125·257	21·015	18·772	6·257	·987108
May 2	352·526	125·521	−20·929	−18·711	+6·175	9·983248
7	·528	125·824	20·829	18·649	6·054	·979484
12	352·531	126·164	−20·715	−18·588	+5·879	9·975837

Greenwich Noon.	Diameter of Ball. Equat.	Phase prec. l.	Polar	Axis of Ring. Major	Minor	*Mimas.* a_1	b_1	l_1−L.	
1887.	″	″	″	″	″	″	″	°	°
Oct. 15	17·57	0·050	16·00	40·50	13·10	27·67	−8·95	87·82	
20	17·72	·052	16·14	40·86	13·15	27·91	8·99	197·69	1909·87
25	17·88	·053	16·29	41·23	13·22	28·17	9·03	307·60	·91
30	18·05	·053	16·44	41·60	13·30	28·43	9·08	57·55	1909·95
Nov. 4	18·21	·053	16·59	41·99	13·39	28·69	−9·15	167·55	1910·00
9	18·38	·052	16·74	42·38	13·49	28·95	9·22	277·59	·04
14	18·55	·051	16·89	42·77	13·61	29·22	9·30	27·67	·08
19	18·72	·048	17·05	43·16	13·74	29·49	9·39	137·79	·12
24	18·89	·045	17·20	43·54	13·88	29·75	9·48	247·96	·17
29	19·05	·041	17·35	43·91	14·03	30·00	9·58	358·17	·21
Dec. 4	19·20	·037	17·49	44·27	14·18	30·24	−9·69	108·41	·24
9	19·35	·032	17·63	44·61	14·35	30·48	9·80	218·68	1910·27
14	19·49	·027	17·75	44·93	14·52	30·70	9·92	328·99	·31
19	19·62	·022	17·87	45·23	14·69	30·90	10·04	79·32	·33
24	19·73	·017	17·98	45·49	14·87	31·08	10·16	189·67	·35
29	19·83	·012	18·07	45·72	15·04	31·24	10·28	300·04	·37
									·39

Greenwich Noon.	Diameter of Ball. Equat.	Phase	Polar prec. l.	Axis of Ring. Major	Minor	*Mimas.* a_1	b_1	l_1-L.	
1888.	″	″	″	″	″	″	″	°	°
Jan. 3	19·92	0·008	18·15	45·91	15·21	31·37	−10·39	50·43	1910·39
8	19·98	·005	18·22	46·06	15·37	31·47	10·50	160·82	·40
13	20·03	·002	18·27	46·18	15 52	31·55	10·60	271·22	·39
18	20·06	·001	18·30	46·24	15·66	31·59	10·70	21·61	·38
23	20·07	foll.	18·31	46·27	15·78	31·61	10·78	131·99	·36
28	20·06	limb.	18·30	46·24	15·89	31·59	10·86	242·35	·34
Feb. 2	20·03	·002	18·28	46·18	15·98	31·55	−10 92	352·69	1910·31
7	19·98	·005	18·24	46·06	16·05	31·47	10·97	103·00	·28
12	19·92	·008	18·18	45·91	16·10	31·37	11·00	213·28	·24
17	19·83	·012	18·11	45·72	16·13	31·24	11·02	323·52	·20
22	19·73	·017	18·02	45·49	16·14	31·08	11·03	73·72	·15
27	19·62	·022	17·92	45·22	16·12	30·90	11·02	183·87	·11
Mar. 3	19·49	·027	17·80	44·93	16·09	30·70	−10·99	293·98	·06
8	19·35	·032	17·68	44·61	16·03	30·48	10·95	44·04	1910·00
13	19·21	·037	17·55	44·27	15·95	30·25	10·90	154·04	1909·95
18	19·05	·041	17·41	43·91	15·86	30·00	10·84	263·99	·90
23	18·89	·045	17·26	43·54	15·75	29·75	10·76	13·89	·85
28	18·72	·048	17·11	43·16	15·63	29·49	10·68	123·74	·79
Apr. 2	18·56	·051	16·96	42·78	15·49	29·23	−10·58	233·53	·74
7	18·39	·053	16·80	42·39	15·34	28 96	10·48	343·27	·70
12	18·22	·054	16·65	42·00	15·18	28·69	10·37	92·97	·65
17	18·05	·054	16·49	41·61	15·01	28·43	10·26	202·62	·60
22	17·88	·054	16·34	41·23	14·83	28·17	10·13	312·22	·56
27	17·72	·053	16·19	40·86	14·65	27·92	10·01	61·78	·52
May 2	17·57	·051	16·04	40·50	14·46	27·67	− 9·88	171·30	·49
7	17·42	·049	15·90	40·15	14·27	27·43	9·75	280·79	1909·45
12	17·27	0·046	15·77	39·81	14·08	27·20	9·62	30·24	

Greenwich Noon.	*Enceladus.* a_2	b_2	l_2-L	Diff.	*Tethys.* a_3	b_3	l_3-L	Diff.
1887.	″	″	°	°	″	″	°	°
Oct. 15	35·50	−11·48	59·85	1313·51	43·94	−14·21	25·41	953·30
20	35·81	11·53	293·36	·55	44·33	14·27	258·71	·35
25	36·13	11·58	166·91	·59	44·73	14·34	132·06	·39
30	36·46	11·65	40·50	·63	45·14	14·43	5·45	·43
Nov. 4	36·80	−11·73	274·13	1313·68	45·56	−14·53	238·88	953·47
9	37·14	11·83	147·81	·72	45·98	14·64	112·35	·52
14	37·48	11·93	21·53	·76	46·40	14·77	345·87	·56
19	37·82	12·04	255·29	·81	46·82	14·90	219·43	61

Greenwich Noon.	*Enceladus.* a_2	b_2	l_2-L	Diff.	*Tethys.* a_3	b_3	l_3-L	Diff.
1887.	″	″	°	°	″	″	°	°
Nov. 24	38·16	12·16	129·10	·85	47·24	15·06	93·04	·69
29	38·49	12·29	2·95	·88	47·64	15·22	326·69	·65
Dec. 4	38·80	−12·43	236·83	1313·92	48·03	−15·39	200·38	953·73
9	39·10	12·58	110·75	·96	48·40	15·57	74·11	·76
14	39·38	12·73	344·71	1313·99	48·75	15·75	307·87	·80
19	39·64	12·88	218·70	1314·02	49·07	15·94	181·67	·83
24	39·87	13·03	92·72	·04	49·35	16·13	55·50	·85
29	40·07	13·18	326·76	·05	49·60	16·32	289·35	·87
1888.								
Jan. 3	40·24	−13·33	200·81	1314·07	49·81	−16·50	163·22	953·89
8	40·37	13·47	74·88	·07	49·98	16·67	37·11	·89
13	40·47	13·60	308·95	·07	50·10	16·84	271·00	·90
18	40·53	13·73	183·02	·07	50·17	16·99	144·90	·90
23	40·55	13·84	57·09	·06	50·20	17·13	18·80	·89
28	40·53	13·93	291·15	·04	50·17	17·24	252·69	·88
Feb. 2	40·47	−14·01	165·19	1314·02	50·10	−17·34	126·57	953·86
7	40·37	14·07	39·21	1313·99	49·98	17·42	0·43	·83
12	40·24	14·11	273·20	·96	49·81	17·47	234·26	·81
17	40·07	14·14	147·16	·92	49·60	17·50	108·07	·77
22	39·87	14·14	21·08	·88	49·35	17·51	341·84	·73
27	39·64	14·13	254·96	·84	49·07	17·49	215·57	·69
Mar. 3	39·38	−14·10	128·80	1313·79	48·75	−17·45	89·26	953·65
8	39·10	14·05	2·59	·74	48·41	17·39	322·91	·60
13	38·81	13·98	236·33	·69	48·04	17·31	196·51	·55
18	38·49	13·90	110·02	·64	47·65	17·21	70·06	·50
23	38·17	13·81	343·66	·59	47·25	17·09	303·56	·45
28	37·83	13·70	217·25	·54	46·83	16·95	177·01	·41
Apr. 2	37·49	−13·58	90·79	1313·49	46·41	−16·80	50·42	953·35
7	37·15	13·44	324·28	·44	45·99	16·64	283·77	·31
12	36·81	13·30	197·72	·40	45·57	16·47	157·08	·27
17	36·47	13·16	71·12	·35	45·15	16·29	30·35	·22
22	36·14	13·00	304·47	·31	44·73	16·09	263·57	·17
27	35·81	12·84	177·78	·27	44·33	15·90	136·74	·14
May 2	35·49	−12·68	51·05	1313·24	43·94	−15·69	9·88	953·10
7	35·29	12·51	284·29	·20	43·56	15·49	242·98	·06
12	34·89	12·34	157·49		43·19	15·28	116·04	

Greenwich Noon.		*Dione.* a_4	b_4	l_4—L	Diff.	*Rhea.* a_5	b_5	l_5—L	Diff.
1887.		″	″	°	°	″	″	°	°
Oct.	15	56·28	−18·20	209·87	657·46	78·59	−25·42	230·36	398·21
	20	56·78	18·28	147·33	·50	79·29	25·52	268·57	·25
	25	57·29	18·37	84·83	·54	80·00	25·65	306·82	·30
	30	57·81	18·48	22·37	·59	80·74	25·80	345·12	·34
Nov.	4	58·35	−18·60	319·96	657·63	81·48	−25·98	23·46	398·38
	9	58·89	18·75	257·59	·68	82·24	26·18	61·84	·43
	14	59·43	18·91	195·27	·72	82·99	26·41	100·27	·47
	19	59·97	19·09	132·99	·77	83·75	26·66	138·74	·52
	24	60·50	19·28	70·76	·81	84·49	26·93	177·26	·56
	29	61·02	19·49	8·57	·85	85·21	27·22	215·82	·60
Dec.	4	61·51	−19·71	306·42	·89	85·91	−27·53	254·42	398·65
	9	61·99	19·94	244·31	·92	86·57	27·85	293·07	·69
	14	62·43	20·18	182·23	657·96	87·19	28·18	331·76	·72
	19	62·84	20·42	120·19	658·00	87·76	28·51	10·48	·75
	24	63·21	20·66	58·19	·02	88·27	28·85	49·23	·79
	29	63·53	20·90	356·21	·04	88·72	29·18	88·02	·81
1888.									
Jan.	3	63·80	−21·13	294·25	658·06	89·09	−29·51	126·83	398·83
	8	64·01	21·36	232·31	·08	89·39	29·82	165·66	·84
	13	64·17	21·57	170·39	·08	89·61	30·12	204·50	·85
	18	64·26	21·76	108·47	·08	89·74	30·39	243·35	·86
	23	64·29	21·93	46·55	·08	89·78	30·63	282·21	·85
	28	64·26	22·09	344·63	·07	89·74	30·84	321·06	·85
Feb.	2	64·17	−22·21	282·70	·05	89·61	−31·02	359·91	398·83
	7	64·01	22·31	220·75	·02	89·39	31·15	38·74	·81
	12	63·80	22·38	158·77	658·00	89·09	31·25	77·55	·79
	17	63·53	22·42	96·77	657·97	88·72	31·31	116·34	·75
	22	63·21	22·43	34·74	·94	88·27	31·32	155·09	·72
	27	62·84	22·40	332·68	·89	87·76	31·29	193·81	·69
Mar.	3	62·44	−22·35	270·57	·85	87·19	−31·22	232·50	398·65
	8	62·00	22·28	208·42	·81	86·58	31·11	271·15	·60
	13	61·52	22·17	146·23	·76	85·92	30·96	309·75	·55
	18	61·03	22·04	83·99	·71	85·22	30·78	348·30	·51
	23	60 51	21·89	21·70	·66	84·50	30·57	26·81	·46
	28	59·98	21·71	319·36	·62	83·76	30·33	65·27	·42
Apr.	2	59·44	−21·52	256·98	657·57	83·01	−30·06	103·69	398·37
	7	58·90	21·32	194·55	·52	82·25	29·77	142·06	·32
	12	58·36	21·09	132·07	·47	81·50	29·46	180·38	·27

Greenwich Noon.	*Dione.* a_4	b_4	l_4—L	Diff.	*Rhea.* a_5	b_5	l_5—L	Diff.
1887.	″	″	°	°	″	″	°	°
Apr. 17	57·82	20·86	69·54	·43	80·75	29·13	218·65	·23
22	57·29	20·61	6·97	·39	80·01	28·79	256·88	·19
27	56·78	20·36	304·36	·35	79·29	28·43	295·07	·15
May 2	56·27	−20·10	241·71	657·31	78·59	−28·07	333·22	398·11
7	55·79	19·84	179·02	·28	77·91	27·70	11·33	·07
12	55·32	19·57	116·30		77·26	27·33	49·40	

Approximate Greenwich mean times of conjunctions of the satellites with the centre of the planet or of their passages in the direction of the minor axis of the ring.

"n" inferior conjunction, or satellite north, moving from the following to the preceding side.

"s" superior conjunction, or satellite south, moving from the preceding to the following side.

In the case of *Titan* and *Iapetus* the approximate distances from the centre or from the major axis of the ring are added, at which they pass in the direction of the minor axis.

1887	h			h			h	
Nov. 1	10·7	Rh. n.	Nov. 10	7·2	Te. s.	Nov. 17	8·2	En. n.
	13·6	Di. s.		11·6	Rh. n.		16·7	Mi. s.
	14·1	En. s.		11·8	En. n.		20·4	Te. s.
	16·2	Mi. s.		15·1	Mi. n.		23·7	Di. s.
	19·3	Te. n.	11	3·5	Di. n.	18	15·3	Mi. s.
2	14·9	Mi. s.		5·8	Te. n.		17·1	En. n.
	17·9	Te. s.		13·7	Mi. n.		19·0	Te. n.
	22·5	Di. n.		20·7	En. n.	19	8·6	Di. n.
	23·0	En. s.	12	4·5	Te. s.		9·6	En. s.
3	13·5	Mi. s.		12·3	Mi. n.		12·4	Rh. n.
	15·4	En. n.		12·4	Di. s.		14·0	Mi. s.
	16·6	Te. n.		13·1	En. s.		17·7	Te. s.
	16·9	Rh. s.		17·8	Rh. s.	20	12·6	Mi. s.
4	7·3	Di. s.		20·2	Tit. n. 58″		16·3	Te. n.
	7·8	En. s.	13	3·1	Te. n.		17·4	Di. s.
	12·1	Mi. s.		10·9	Mi. n.		18·4	En. s.
	15·2	Te. s.		21·2	Di. n.		23·8	Tit. s. 62′
5	1·0	Tit. s. 61″		22·0	En. s.	21	10·9	En. n.
	13·9	Te. n.	14	1·8	Te. s.		11·2	Mi. s.
	16·2	Di. n.		8·7	Iap. s. 52″		15·0	Te. s.
	16·7	En. s.		14·5	En. n.		18·6	Rh. s.
	23·1	Rh. n.		20·9	Mi. s.	22	2·2	Di. n.
6	12·5	Te. s.	15	0·0	Rh. n.		13·6	Te. n.
7	1·0	Di. s.		0·4	Te. n.		19·8	En. n.
	11·2	Te. n.		6·1	Di. s.		21·1	Mi. n.
8	5·4	Rh. s.		6·9	En. s.	23	11·1	Di. s.
	9·8	Di. n.		19·5	Mi. s.		12·2	En. s.
	9·9	Te. s.		23·1	Te. s.		12·3	Te. s.
	10·5	En. s.	16	14·9	Di. n.		19·7	Mi. n.
9	8·5	Te. n.		15·8	En. s.	24	0·8	Rh. n.
	16·5	Mi. n.		18·1	Mi. s.		10·9	Te. n.
	18·7	Di. s.		21·7	Te. n.		18·3	Mi. n.
	19·4	En. s.	17	6·2	Rh. s.		19·9	Di. n.

1887	h			h			h	
Nov. 24	21·1	En. s.	Dec. 8	10·3	Mi. s.	Dec. 21	19·7	Te. s.
25	9·6	Te. s.		12·3	Di. n.	22	4·6	Di. n.
	13·5	En. n.		13·9	En. s.		6·7	En. s.
	17·0	Mi. n.		14·7	Te. s.		13·5	Mi. s.
26	4·8	Di. s.	9	13·3	Te. n.		18·4	Te. n.
	7·0	Rh. s.		20·1	Rh. s.		20·0	Tit. s. 66″
	8·2	Te. n.		20·2	Mi. n.	23	9·2	Rh. s.
	15·6	Mi. n.		21·1	Di. s.		12·1	Mi. s.
	22·4	En. n.		22·8	En. s.		13·4	Di. s.
27	6·9	Te. s.	10	12·0	Te. s.		15·5	En. s.
	13·6	Di. n.		15·2	En. n.		17·0	Te. s.
	14·2	Mi. n.		18·8	Mi. n.	24	8·0	En. n.
	14·8	En. s.	11	5·9	Di. n.		10·7	Mi. s.
28	5·5	Te. n.		7·6	En. s.		15·7	Te. n.
	7·3	En. n.		10·6	Te. n.		19·5	Iap. n. 58″
	12·8	Mi. n.		17·4	Mi. n.		22·2	Di. n.
	13·2	Rh. n.	12	2·3	Rh. n.	25	14·3	Te. s.
	18·7	Tit. n. 60″		9·3	Te. s.		15·3	Rh. n.
	22·4	Di. s.		14·8	Di. s.		16·8	En. n.
29	4·2	Te. s.		16·0	Mi. n.		20·6	Mi. n.
	11·4	Mi. n.		16·5	En. s.	26	7·0	Di. s.
	16·2	En. n.	13	7·9	Te. n.		9·3	En. s.
	22·7	Mi. s.		9·0	En. n.		12·9	Te. n.
30	2·8	Te. n.		14·6	Mi. n.		19·2	Mi. n.
	7·3	Di. n.		23·6	Di. n.	27	11·6	Te. s.
	8·6	En. s.	14	6·6	Te. s.		15·9	Di. n.
	10·0	Mi. n.		8·5	Rh. s.		17·8	Mi. n.
	19·4	Rh. s.		13·3	Mi. n.		18·2	En. s.
Dec. 1	1·5	Te. s.		16·9	Tit. n. 62″		21·5	Rh. s.
	16·1	Di. s.		17·8	En. n.	28	10·2	Te. n.
	17·5	En. s.	15	5·2	Te. n.		10·6	En. n.
	20·0	Mi. s.		8·4	Di. s.		16·5	Mi. n.
2	0·1	Te. n.		10·3	En. s.	29	0·7	Di. s.
	9·9	En. n.		11·9	Mi. n.		8·9	Te. s.
	18·6	Mi. s.	16	3·8	Te. s.		15·1	Mi. n.
	22·8	Te. s.		10·5	Mi. n.		19·5	En. n.
3	0·9	Di. n.		14·7	Rh. n.	30	3·7	Rh. n.
	1·6	Rh. n.		17·2	Di. n.		7·5	Te. n.
	17·2	Mi. s.		19·1	En. s.		9·5	Di. n.
	18·8	En. n.	17	2·5	Te. n.		11·9	En. s.
	21·4	Te. n.		11·6	En. n.		13·7	Mi. n.
4	9·8	Di. s.		20·4	Mi. s.		14·8	Tit. n. 64″
	11·2	En. s.	18	1·1	Te. s.	31	6·2	Te. s.
	15·8	Mi. s.		2·1	Di. s.		12·3	Mi. n.
	20·1	Te. s.		19·0	Mi. s.		18·3	Di. s.
5	7·8	Rh. s.		20·5	En. n.		20·8	En. s.
	14·4	Mi. s.		20·8	Rh. s.	1888	h	
	18·6	Di. n.		23·8	Te. n.	Jan. 1	4·8	Te. n.
	18·7	Te. n.	19	10·9	Di. n.		9·8	Rh. s.
	20·1	En. s.		12·9	En. s.		10·9	Mi. n.
6	12·6	En. n.		17·6	Mi. s.		13·2	En. n.
	13·0	Mi. s.		22·4	Te. s.	2	3·2	Di. n.
	17·4	Te. s.	20	16·2	Mi. s.		3·5	Te. s.
	22·0	Tit. s. 64″		19·7	Di. s.		20·8	Mi. s.
7	3·4	Di. s.		21·1	Te. n.		22·1	En. n.
	11·6	Mi. s.		21·8	En. s.	3	2·1	Te. n.
	14·0	Rh. n.	21	3·0	Rh. n.		12·0	Di. s.
	16·0	Te. n.		14·2	En. n.		14·5	En. s.
	21·4	En. n.		14·9	Mi. s.		16·0	Rh. n.

1888

	h							h				
Jan.	3	19·4	Mi. s.		Jan.	17	5·8	Te. s.		Jan.	31	14·5	Mi. n.
	4	0·8	Te. s.				7·3	En. s.				16·5	En. n.
		7·0	En. n.				11·3	Mi. n.				19·0	Iap. s. 71″
		18·1	Mi. s.			18	4·4	Te. n.		Feb.	1	5·3	Di. n.
		20·8	Di. n.				9·9	Mi. n.				8·1	Te. s.
		23·4	Te. n.				13·0	Di. n.				8·9	En. s.
	5	15·8	En. n.				16·2	En. s.				13·1	Mi. n.
		16·7	Mi. s.			19	3·1	Te. s.			2	0·0	Rh. s.
		22·0	Te. s.				8·6	Mi. n.				6·7	Te. n.
		22·1	Rh. s.				8·6	En. n.				11·8	Mi. n.
	6	5·6	Di. s.				11·1	Rh. s.				14·1	Di. s.
		8·3	En. s.				21·9	Di. s.				17·8	En. s.
		15·3	Mi. s.			20	1·7	Te. n.			3	5·4	Te. s.
		20·7	Te. n.				17·5	En. n.				10·2	En. n.
	7	13·9	Mi. s.				18·5	Mi. s.				10·4	Mi. n.
		14·5	Di. n.			21	0·3	Te. s.				22·9	Di. n.
		17·2	En. s.				6·7	Di. n.			4	4·0	Te. n.
		17·4	Tit. s. 68″				9·9	En. s.				6·2	Rh. n.
		19·3	Te. s.				17·1	Mi. s.				9·0	Mi. n.
	8	4·3	Rh. n.				17·2	Rh. n.				19·1	En. n.
		9·6	En. n.				23·0	Te. n.			5	2·7	Te. s.
		12·5	Mi. s.			22	15·5	Di. s.				7·6	Mi. n.
		18·0	Te. n.				15·7	Mi. s.				7·7	Di. s.
		23·3	Di. s.				18·8	En. s.				11·5	En. s.
	9	11·1	Mi. s.				21·6	Te. s.			6	1·3	Te. n.
		16·6	Te. s.			23	11·2	En. n.				4·0	En. n.
		18·5	En. n.				14·3	Mi. s.				6 2	Mi. n.
	10	8·1	Di. n.				14·6	Tit. s. 70″				12·3	Rh. s.
		9·7	Mi. s.				20·3	Te. n.				16·6	Di. n.
		10·5	Rh. s.				23·4	Rh. s.				23·9	Te. s.
		10·9	En. s.			24	0·3	Di. n.			7	12·8	En. n.
		15·3	Te. n.				12·9	Mi. s.				16·1	Mi. s.
	11	13·9	Te. s.				18·9	Te. s.				22·6	Te. n.
		16·9	Di. s.				20·1	En. n.			8	1·4	Di. s.
		19·7	Mi. n.			25	9·2	Di. s.				5·3	En. s.
		19·8	En. s.				11·5	Mi. s.				12·0	Tit. s. 72″
	12	12·2	En. n.				12·5	En. s.				14·8	Mi. s.
		12·5	Te. n.				17·6	Te. n.				18·5	Rh. n.
		16·6	Rh. n.			26	5·6	Rh. n.				21·2	Te. s.
		18·3	Mi. n.				10·2	Mi. s.			9	10 2	Di. n.
	13	1·7	Di. n.				16·2	Te. s.				13·4	Mi. s.
		11·2	Te. s.				18·0	Di. n.				14·2	En. s.
		16·9	Mi. n.				21·4	En. s.				19·9	Te. n.
		21·1	En. n.			27	13·8	En. n.			10	6·6	En. n.
	14	9·8	Te. n.				14 9	Te. n.				12·0	Mi. s.
		10·6	Di. s.			28	2·8	Di. s.				18·5	Te. s.
		13·5	En. s.				11·7	Rh. s.				19·0	Di. s.
		15·5	Mi. n.				13·5	Te. s.			11	0·7	Rh. s.
		22·8	Rh. s.			29	11·6	Di. n.				10·6	Mi. s.
	15	6·0	En. n.				12·1	Te. n.				15·5	En. n.
		8·5	Te. s.				15·2	En. s.				17·2	Te. n.
		12·1	Tit. n. 66″				17·3	Mi. n.			12	3·9	Di. n.
		14·1	Mi. n.			30	7·6	En. n.				7·9	En. s.
		19·4	Di. n.				10·8	Te. s.				9·2	Mi. s.
	16	7·1	Te. n.				15·9	Mi. n.				15·8	Te. s.
		12·7	Mi. n.				17·9	Rh. n.			13	6·8	Rh. n.
		14·8	En. n.				20·4	Di. s.				7·8	Mi. s.
	17	4·2	Di. s.			31	9·4	Te. n.				12·7	Di. s.
		4·9	Rh. n.				9·6	Tit. n. 67″				14·5	Te. n.

1888	h		
Feb. 13	16·8	En. s.	
14	6·4	Mi. s.	
	9·2	En. n.	
	13·1	Te. s.	
	21·5	Di. n.	
15	11·8	Te. n.	
	13·0	Rh. s.	
	16·4	Mi. n.	
	18·1	En. n.	
16	6·3	Di. s.	
	7·1	Tit. n.	68″
	10·4	Te. s.	
	10·6	En. s.	
	15·0	Mi. n.	
17	9·0	Te. n.	
	13·6	Mi. n.	
	15·2	Di. n.	
	19·2	Rh. n.	
	19·4	En. s.	
18	7·7	Te. s.	
	11·9	En. n.	
	12·2	Mi. n.	
19	0·0	Di. s.	
	4·3	En. s.	
	6·3	Te. n.	
	10·8	Mi. n.	
20	1·3	Rh. s.	
	5·0	Te. s.	
	8·8	Di. n.	
	9·4	Mi. n.	
	13·2	En. s.	
21	3·6	Te. n.	
	5·6	En. n.	
	8·1	Mi. n.	
	17·7	Di. s.	
22	2·3	Te. s.	
	6·7	Mi. n.	
	7·5	Rh. n.	
	14·5	En. n.	
23	0·9	Te. n.	
	2·5	Di. n.	
	7·0	En. s.	
	23·6	Te. s.	
24	9·5	Tit. s.	72″
	11·3	Di. s.	
	13·7	Rh. s.	
	22·2	Te. n.	
25	8·3	En. n.	
	13·8	Mi. s.	
	20·1	Di. n.	
	20·9	Te. s.	
26	12·4	Mi. s.	
	17·1	En. n.	
	19·5	Te. n.	
	19·8	Rh. n.	
27	5·0	Di. s.	
	9·6	En. s.	
	11·1	Mi. s.	
	18·2	Te. s.	
Feb. 28	2·0	En. n.	
	9·7	Mi. s.	
	13·8	Di. n.	
	16·8	Te. n.	
29	2·0	Rh. s.	
	8·3	Mi. s.	
	10·9	En. n.	
	15·5	Te. s.	
	22·6	Di. s.	
Mar. 1	3·4	En. s.	
	6·9	Mi. s.	
	14·1	Te. n.	
2	5·5	Mi. s.	
	7·5	Di. n.	
	8·2	Rh. n.	
	12·2	En. s.	
	12·8	Te. s.	
3	4·7	En. n.	
	4·9	Tit. n.	68″
	11·4	Te. n.	
	15·4	Mi. n.	
	16·3	Di. s.	
4	10·1	Te. s.	
	13·6	En. n.	
	14·1	Mi. n.	
	14·4	Rh. s.	
5	1·1	Di. n.	
	6·0	En. s.	
	8·7	Te. n.	
	12·7	Mi. n.	
6	7·4	Te. s.	
	10·0	Di. s.	
	11·3	Mi. n.	
	14·9	En. s.	
	20·6	Rh. n.	
7	6·0	Te. n.	
	7·3	En. n.	
	9·9	Mi. n.	
	18·8	Di. n.	
8	4·7	Te. s.	
	8·5	Mi. n.	
	16·2	En. n.	
9	2·7	Rh. s.	
	3·3	Te. n.	
	3·6	Di. s.	
	7·2	Mi. n.	
	8·6	En. s.	
10	2·0	Te. s.	
	12·5	Di. n.	
	17·1	Mi. s.	
	17·5	En. s.	
11	0·6	Te. n.	
	7·4	Tit. s.	72″
	8·9	Rh. n.	
	10·0	En. n.	
	15·7	Mi. s.	
	21·3	Di. s.	
	23·3	Te. s.	
12	1·0	Iap. n.	74″
Mar. 12	14·3	Mi. s.	
	18·9	En. n.	
	21·9	Te. n.	
13	6·2	Di. n.	
	11·3	En. s.	
	12·9	Mi. s.	
	15·1	Rh. s.	
	20·6	Te. s.	
14	3·7	En. n.	
	11·6	Mi. s.	
	15·0	Di. s.	
	19·2	Te. n.	
15	10·2	Mi. s.	
	12·6	En. n.	
	17·9	Te. s.	
	21·3	Rh. n.	
	23·8	Di. n.	
16	5·1	En. s.	
	8·8	Mi. s.	
	16·5	Te. n.	
17	7·4	Mi. s.	
	8·7	Di. s.	
	13·9	En. s.	
	15·2	Te. s.	
18	3·5	Rh. s.	
	6·0	Mi. s.	
	6·4	En. n.	
	13·8	Te. n.	
	17·5	Di. n.	
19	2·9	Tit. n.	68″
	12·5	Te. s.	
	15·3	En. n.	
	16·0	Mi. n.	
20	2·4	Di. s.	
	7·7	En. s.	
	9·7	Rh. n.	
	11·1	Te. n.	
21	9·8	Te. s.	
	11·2	Di. n.	
22	8·4	Te. n.	
	15·9	Rh. s.	
	20·0	Di. s.	
23	7·1	Te. s.	
24	4·9	Di. n.	
	5·8	Te. n.	
	9·1	Mi. n.	
	10·4	En. s.	
	22·1	Rh. n.	
25	2·8	En. n.	
	4·4	Te. s.	
	7·7	Mi. n.	
	13·7	Di. s.	
26	3·1	Te. n.	
	6·3	Mi. n.	
	11·7	En. n.	
	22·6	Di. n.	
27	1·7	Te. s.	
	4·1	En. s.	
	4·3	Rh. s.	

1888	h			h			h	
Mar. 27	4·9	Mi. n.	Apr. 8	6·2	Di. s.	Apr. 20	0·7	Tit. n. 64″
	5·7	Tit. s. 70″		8·2	Te. n.		13·9	Di. n.
28	0·3	Te. n.		11·0	Mi. n.		14·8	Te. s.
	7·4	Di. s.		12·1	En. s.	21	0·8	Rh. n.
	13·0	En. s.	9	4·6	En. n.		13·5	Te. n.
	14·8	Mi. s.		6·9	Te. s.		22·7	Di. s.
	23·0	Te. s.		9·6	Mi. n.	22	12·1	Te. s.
29	5·5	En. n.		15·0	Di. n.	23	7·1	Rh. s.
	10·5	Rh. n.		17·7	Rh. s.		7·6	Di. n.
	13·5	Mi. s.	10	5·6	Te. n.		10·8	Te. n.
	16·3	Di. n.		8·2	Mi. n.	24	9·5	Te. s.
	21·7	Te. n.		13·5	En. n.		16·4	Di. s.
30	12·1	Mi. s.		23·9	Di. s.	25	8·1	Te. n.
	14·4	En. n.	11	4·2	Te. s.		13·3	Rh. n.
	20·3	Te. s.		5·9	En. s.	26	1·3	Di. n.
31	1·1	Di. s.		6·8	Mi. n.		6·8	Te. s.
	6·8	En. s.		23·9	Rh. n.	27	5·4	Te. n.
	10·7	Mi. s.	12	2·9	Te. n. 68″		10·2	Di. s.
	16·8	Rh. s.		4·6	Tit. s.		19·6	Rh. s.
	19·0	Te. n.		8·7	Di. n.	28	4·0	Tit. s. 66″
Apr. 1	9·3	Mi. s.		14·8	En. s.		4·1	Te. s.
	9·9	Di. n.	13	1·5	Te. s.		19·0	Di. n.
	15·7	En. s.		7·3	En. n.	29	2·8	Te. n.
	17·6	Te. s.		17·6	Di. s.	30	1·4	Te. s.
2	7·9	Mi. s.	14	0·2	Te. n.		1·8	Rh. n.
	8·1	En. n.		6·1	Rh. s.		3·9	Di. s.
	16·3	Te. n.		14·0	Mi. s.	May 1	0·1	Te. n.
	18·8	Di. s.		16·2	En. n.		12·7	Di. n.
	23·0	Rh. n.		22·9	Te. s.		22·8	Te. s.
3	6·6	Mi. s.	15	2·4	Di. n.	2	8·1	Rh. s.
	15·0	Te. s.		8·6	En. s.		21·4	Te. n.
	17·0	En. n.		12·6	Mi. s.		21·6	Di. s.
4	1·6	Tit. n. 66″		21·5	Te. n.	3	20·1	Te. s.
	3·6	Di. n.	16	11·3	Mi. s.	4	6·5	Di. n.
	9·5	En. s.		11·3	Di. s.		14·3	Rh. n.
	13·6	Te. n.		12·3	Rh. n.		18·7	Te. n.
5	5·2	Rh. s.		17·5	En. s.	5	15·3	Di. s.
	12·3	Te. s.		20·2	Te. s.		17·4	Te. s.
	12·5	Di. s.	17	9·9	Mi. s.	6	16·1	Te. n.
6	10·8	En. n.		9·9	En. n.		20·6	Rh. s.
	10·9	Te. n.		18·8	Te. n.	7	0·2	Di. n.
	13·7	Mi. n.		20·2	Di. n.		0·2	Tit. n. 62″
	21·3	Di. n.	18	14·2	Iap. s. 72″		14·7	Te. s.
7	3·3	En. s.		17·5	Te. s.	8	9·0	Di. s.
	9·6	Te. s.		18·6	Rh. s.		13·4	Te. n.
	11·4	Rh. n.	19	5·0	Di. s.	9	2·8	Rh. n.
	12·4	Mi. n.		16·2	Te. n.			

By means of this list of conjunctions of the five inner satellites, approximate values of their co-ordinates x and y, expressed in semi-diameters of the planet's equator, may be easily found for any other time t in the following little table, the argument of which is the interval τ between the time t and the time of the next preceding or following conjunction. The satellites are on the same side, north or south, of the major axis of the ring as at the time of the next conjunction, and as they move in the direction of *de*creasing position-angles, they are in the interval between

a N. and a S. conjunction on the preceding side, and between a S. and a N. conjunction on the following side of the direction of the minor axis of the ring. They are at their greatest elongations, Mi. 5·7, En. 8·2, Te. 11·3, Di. 16·4, Rh. 27·1 hours before or after the times of conjunction.

τ	*Mimas.*		*Enceladus.*		*Tethys.*		*Dione.*		*Rhea.*	
h	x_1	y_1	x_2	y_2	x_3	y_3	x_4	y_4	x_5	y_5
0	0·0	1·1	0·0	1·4	0·0	1·7	0·0	2·2	0·0	3·0
1	0·9	1·1	0·8	1·4	0·7	1·7	0·6	2·2	0·5	3·0
2	1·7	0·9	1·5	1·3	1·4	1·7	1·2	2·1	1·0	3·0
3	2·3	0·7	2·2	1·2	2·0	1·6	1·8	2·1	1·5	3·0
4	2·8	0·5	2·8	1·0	2·6	1·5	2·4	2·0	2·0	3·0
5	3·1	0·2	3·3	0·8	3·2	1·3	2·9	1·9	2·5	2·9
6	3·1	0·1	3·7	0·6	3·7	1·1	3·5	1·8	3·0	2·9
7	2·9	0·4	3·9	0·3	4·1	0·9	4·0	1·7	3·5	2·8
8	2·5	0·6	4·0	0·1	4·5	0·8	4·4	1·6	4·0	2·7
9	1·8	0·8	4·0	0·2	4·7	0·6	4·8	1·5	4·5	2·6
10	1·1	1·0	3·8	0·5	4·9	0·3	5·2	1·3	4·9	2·5
11					5·0	0·1	5·6	1·1	5·3	2·4
12							5·8	0·9	5·7	2·3
14							6·2	0·5	6·5	2·1
16							6·4	0·1	7·1	1·8
20									8·2	1·2
27·1									8·9	0·0

Observers who are desirous to follow the motions of the satellites will find it of service to lay down the data of the table graphically on a sufficiently large scale, so that, by marking the corresponding times for the night of observing, they may get information about the places of the satellites at a glance.

Careful observations of the position-angles of the satellites at the times of their passing the direction of the minor axis of the ring afford the best means for determining the longitudes of the satellites in their orbits and are least liable to systematic errors, so that their evidence must be of very great weight in settling any questions concerning the orbital longitudes.

As the present apparition of *Saturn* is the last one, for some years to come, which will allow observations of the conjunctions of *Mimas* with the centre of the ball, it is to be hoped that the opportunities for observing such conjunctions with the powerful telescopes now available will not be neglected.

Approximate Differences of Right Ascension and Declination between the three outer Satellites and the Centre of Saturn.

Greenwich Noon. 1887.		*Titan.*		*Hyperion.*		*Iapetus.*	
		$\alpha_6-A.$	$\delta_6-D.$	$\alpha_7-A.$	$\delta_7-D.$	$\alpha_8-A.$	$\delta_8-D.$
		s	″	s	″	s	″
Oct.	15	−12·34	− 2·1	− 1·68	+60·0	−23·92	+16·2
	16	−12·97	−25·4	− 6·56	+47·2	26·13	11·5
	17	−11·71	−45·0	−10·73	+29·1	−28·19	− 6·7
	18	− 8·79	−58·3	−13·82	+ 7·9	30·07	+ 1·9
	19	− 4·63	−63·4	−15·65	−14·1	−31·75	− 2·9
	20	+ 0·20	−59·6	−16·18	−35·0	33·23	7·7
	21	+ 5·02	−47·3	−15·49	−53·3	−34·49	−12·4
	22	+ 9·12	−28·1	−13·72	−67·9	35·52	17·0
	23	−11·86	− 4·6	−11·05	−78·2	−36·33	−21·5
	24	+12·76	+19·7	− 7·67	−83·5	36·90	25·9
	25	+11·61	+40·8	− 3·80	−83·6	−37·22	−30·1
	26	+ 8·55	+55·2	+ 0·32	−78·6	37·30	34·1
	27	+ 4·05	+60·5	+ 4·43	−68·5	−37·14	−37·9
	28	− 1·14	+55·7	+ 8·25	−53·9	36·74	41·4
	29	− 6·16	+41·8	+11·50	−35·4	−36·09	−44·7
	30	−10·22	+21·1	+13·87	−14·1	35·21	47·7
	31	−12·72	− 2·9	+15·04	+ 8·5	−34·10	−50·5
Nov.	1	−13·33	−26·6	+14·78	+30·3	32·76	52·9
	2	−12·00	−46·4	+12·95	+48·9	−31·21	−54·9
	3	− 8·96	−59·8	+ 9·60	+61·8	29·46	56·6
	4	− 4·64	−64·7	+ 5·06	+67·2	−27·52	−58·0
	5	+ 0·35	−60·6	− 0·12	+64·1	25·39	59·1
	6	+ 5·30	−47·7	− 5·32	+53·1	−23·10	−59·8
	7	+ 9·49	−27·8	− 9·93	+36·0	20·66	60·1
	8	+12·26	− 3·7	−13·52	+14·9	−18·08	−60·1
	9	+13·12	+21·1	−15·85	− 7·6	15·38	59·7
	10	+11·87	+42·5	−16·83	−29·6	−12·57	−58·9
	11	+ 8·65	+57·0	−16·52	−49·4	9·67	57·8
	12	+ 3·97	+62·0	−15·03	−65·7	− 6·71	−56·4
	13	− 1·38	+56·7	−12·53	−77·8	3·69	54·6
	14	− 6·54	+42·0	− 9·22	−85·0	− 0·64	−52·5
	15	−10·67	+20·6	− 5·33	−86·9	+ 2·42	50·1
	16	−13·17	− 4·1	− 1·09	−83·4	+ 5·49	−47·4
	17	−13·70	−28·3	+ 3·24	−74·7	8·53	44·4
	18	−12·25	−48·5	+ 7·36	−60·7	+11·54	−41·2
	19	− 9·04	−61·9	+10·97	−42·7	14·50	37·7

Greenwich Noon. 1887.	$a_6-A.$	$\delta_6-D.$	$a_7-A.$	$\delta_7-D.$	$a_8-A.$	$\delta_8-D.$
	s	″	s	″	s	″
Nov. 20	− 4·54	−66·6	+13·75	−21·2	+17·38	−33·9
21	+ 0·61	−61·8	+15·38	+ 2·1	20·16	29·9
22	+ 5·70	−48·2	+15·56	+25·2	+22·84	−25·2
23	+ 9·96	−27·5	+14·12	+45·8	25·40	21·5
24	+12·72	− 2·5	+11·05	+61·1	+27·83	−17·0
25	+13·49	+23·0	+ 6·62	+69·1	30·10	12·4
26	+12·08	+44·8	+ 1·34	+68·4	+32·20	+ 7·7
27	+ 8·66	+59·3	− 4·13	+59·1	34·12	− 2·9
28	+ 3·78	+63·9	− 9·14	+42·9	+35·85	+ 1·9
29	− 1·76	+57·9	−13·19	+21·9	37·38	6·7
30	− 7·02	+42·3	−15·98	− 1·4	+38·69	+11·6
Dec. 1	+11·19	+19·8	−17·38	−24·6	39·78	16·4
2	−13·64	− 5·8	−17·40	−46·1	+40·64	+21·1
3	−14·05	−30·7	−16·16	−64·3	41·26	25·8
4	−12·42	−51·2	−13·82	−78·2	+41·64	+30·3
5	− 9·01	−64·6	−10·58	−87·2	41·77	34·7
6	− 4·31	−68·6	− 6·67	−90·8	+41·65	+39·0
7	+ 1·02	−63·3	− 2·32	−88·7	41·28	43·0
8	+ 6·26	−49·0	+ 2·18	−81·0	+40·65	+46·8
9	+10·50	−26·8	+ 6·56	−67·9	39·77	50·4
10	+13·20	− 0·8	+10·48	−50·0	+38·64	+53·7
11	+13·82	+25·5	+13·62	−28·3	37·27	56·7
12	+12·20	+47·7	+15·64	− 4·1	+35·67	+59·3
13	+ 8·54	+62·1	+16·21	+20·5	33·84	61·6
14	+ 3·44	+66·1	+15·11	+43·0	+31·78	+63·6
15	− 2·25	+59·1	+12·31	+60·8	29·51	65·1
16	− 7·60	+42·3	+ 8·00	+71·2	+27·05	+66·3
17	−11·75	+18·7	+ 2·67	+72·7	24·41	67·0
18	−14·09	− 8·0	− 3·03	+65·1	+21·60	+67·3
19	−14·33	−33·6	− 8·36	+49·7	18·64	67·2
20	−12·47	−54·5	−12·80	+28·6	+15·55	+66·6
21	− 8·83	−67·6	−15·99	+ 4·6	12·34	65·6
22	− 3·93	−71·3	−17·75	−20·0	+ 9·04	+64·2
23	+ 1·55	−64·8	−18·07	−43·1	5·67	62·2
24	+ 6·81	−49·2	−17·06	−63·2	+ 2·26	+59·9
25	+11·07	−25·8	−14·86	−79·0	− 1·17	57·1
26	+13·65	+ 1·4	−11·69	−89·7	− 4·61	+53·9
27	+14·06	+28·5	− 7·77	−94·8	8·03	50·2

Greenwich Noon.	$\alpha_6-A.$	$\delta_6-D.$	$\alpha_7-A.$	$\delta_7-D.$	$\alpha_8-A.$	$\delta_8-D.$
1887.	s	″	s	″	s	″
Dec. 28	+12·19	−51·0	− 3·35	−94·0	−11·39	+46·2
29	+ 8·27	+65·1	+ 1·29	−87·3	14·69	41·9
30	+ 2·96	+68·3	+ 5·85	−74·8	−17·89	+37·2
31	− 2·86	+60·1	+10·01	−57·1	20·97	32·1
1888.						
Jan. 1	− 8·23	+42·0	+13·43	− 35·1	−23·91	+26·8
2	−12·29	+16·9	+15·75	−10·2	26·69	21·3
3	−14·46	−10·6	+16·65	+15·7	−29·29	+15·5
4	−14·47	−36·9	+15·86	+40·1	31·68	9·6
5	−12·37	−57·9	+13·32	+60·1	−33·85	+ 3·5
6	− 8·50	−70·7	+ 9·17	+72·9	35·79	− 2·6
7	− 3·41	−73·5	+ 3·86	+76·6	−37·48	− 8·8
8	+ 2·18	−65·9	− 1·95	+70·6	38·90	15·0
9	+ 7·45	−48·7	− 7·54	+ 56·1	−40·05	−21·2
10	+11·61	−24·2	−12·29	+ 35·1	40·92	27·2
11	+14·00	+ 4·0	−15·80	+ 10·4	+41·51	−33·1
12	+14·17	+31·7	−17·86	− 15·4	41·81	39·9
13	+12·02	+54·3	−18·45	− 40·0	−41·81	44·4
14	+ 7·86	+67·9	−17·63	− 61·7	41·52	49·7
15	+ 2·37	+70·1	−15·58	− 79·2	−40·95	−54·7
16	− 3·51	+60·6	−12·50	− 91·6	40·09	59·3
17	− 8·83	+41·1	− 8·62	− 98·1	−38·96	−63·6
18	−12·75	+14·9	− 4·20	− 98·6	37·56	67·5
19	−14·70	−13·6	+ 0·50	− 92·8	−35·91	−70·9
20	−14·46	−40·3	+ 5·16	− 81·0	34·02	73·9
21	−12·10	−61·1	+ 9·46	− 63·6	−31·89	−76·4
22	− 8·01	−73·7	+13·07	− 41·6	29·55	78·4
23	− 2·79	−75·2	+15·63	− 16·2	−27·02	−80·0
24	+ 2·84	−66·7	+16·80	+ 10·7	24·31	81·0
25	+ 8·05	−47·8	+16·31	+ 36·6	−21·44	−81·4
26	+12·06	−22·2	+14·04	+ 58·4	18·43	81·4
27	+14·21	+ 6·9	+10·11	+ 73·4	−15·30	−80·8
28	+14·10	+34·9	+ 4·92	+ 79·2	12·08	79·6
29	+11·69	+57·3	− 0·90	+ 75·0	− 8·78	−78·0
30	+ 7·32	+70·1	− 6·62	+ 61·6	5·43	75·8
31	+ 1·73	+71·2	−11·58	+ 41·0	− 2·04	−73·2
Feb. 1	− 4·16	+60·4	−15·33	+ 16·1	+ 1·37	70·0
2	− 9·36	+39·6	−17·65	− 10·4	+ 4·76	−66·4
3	−13·07	+12·5	−18·47	− 36·1	8·12	62·3

Greenwich Noon. 1888.		α_6–A.	δ_6–D.	α_7–A.	δ_7–D.	α_8–A.	δ_8–D.
		s	″	s	″	s	″
Feb.	4	−14·77	−16·6	−17·87	− 59·2	+11·42	−57·8
	5	−14·26	−43·3	−16·00	− 78·0	14·65	53·0
	6	−11·68	−63·8	−13·06	− 91·7	+17·79	−47·8
	7	− 7·43	−75·2	− 9·29	− 99·6	20·82	42·3
	8	− 2·13	−75·9	− 4·94	−101·3	+23·73	−36·4
	9	+ 3·46	−65·9	− 0·28	− 96·6	26·48	30·3
	10	+ 8·55	−46·2	+ 4·39	− 85·6	+29·07	−23·9
	11	+12·35	−19·7	+ 8·75	− 69·0	31·49	17·3
	12	+14·24	+ 9·8	+12·47	− 47·3	+33·71	−10·7
	13	+13·87	+37·8	+15·21	− 22·0	35·72	− 3·9
	14	+11·23	+59·6	+16·62	+ 5·2	+37·52	+ 2·9
	15	+ 6·72	+71·4	+16·42	+ 31·9	39·09	9·8
	16	+ 0·86	+71·3	+14·48	+ 55·1	+40·42	+16·6
	17	− 4·72	+59·3	+10·86	+ 71·9	41·51	23·3
	18	− 9·75	+37·6	+ 5·89	+ 79·8	+42·34	+29·9
	19	−13·22	+ 9·9	+ 0·20	+ 77·6	42·91	36·4
	20	−14·66	−19·4	− 5·52	+ 65·7	+43·23	+42·7
	21	−13·92	−45·8	−10·59	+ 46·2	43·29	48·7
	22	−11·16	−65·5	−14·54	+ 21·8	+43·08	+54·4
	23	− 6·81	−76·0	−17·08	− 4·8	42·60	59·8
	24	− 1·51	−75·6	−18·15	− 31·0	+41·87	+64·9
	25	+ 3·99	−64·6	−17·79	− 54·8	40·89	69·6
	26	+ 8·90	−44·2	−16·16	− 74·7	+39·66	+73·8
	27	+12·47	−17·2	−13·44	− 89·5	38·19	77·6
	28	+14·11	+12·3	− 9·86	− 98·6	+36·48	+81·0
	29	+13·50	+39·9	− 5·68	−101·5	34·54	83·8
Mar.	1	+10·70	+60·8	− 1·15	− 98·1	+32·40	+86·0
	2	+ 6·11	+71·6	+ 3·44	− 88·4	30·06	87·7
	3	+ 0·52	+70·4	+ 7·78	− 72·9	+27·53	+88·9
	4	− 5·15	+57·5	+11·56	− 52·3	24·82	89·5
	5	−10·01	+35·2	+14·44	− 27·7	+21·98	+89·5
	6	−13·20	+ 7·4	+16·09	− 0·7	19·00	88·9
	7	−14·41	−21·6	+16·23	+ 25·9	+15·91	+87·8
	8	−13·48	−47·3	+14·68	+ 50·0	12·72	86·0
	9	−10·60	−66·2	+11·46	+ 68·2	+ 9·46	+83·7
	10	− 6·23	−75·6	+ 6·85	+ 78·1	6·14	80·8
	11	− 0·99	−74·4	+ 1·39	+ 78·1	+ 2·80	+77·4
	12	+ 4·37	−62·6	− 4·22	+ 68·4	− 0·55	73·4

Greenwich Noon. 1888.	$\alpha_6-A.$	$\delta_6-D.$	$\alpha_7-A.$	$\delta_7-D.$	$\alpha_8-A.$	$\delta_8-D.$
	s	″	s	″	s	″
Mar. 13	+ 9·08	−41·8	− 9·33	+50·6	− 3·88	+68·9
14	+12·42	−14·8	−13·42	+27·4	7·18	64·0
15	+13·84	+14·3	−16·19	+ 1·5	−10·42	+58·7
16	+13·06	+41·1	−17·53	−24·5	13·57	52·9
17	+10·15	+61·1	−17·48	−48·6	−16·62	+46·8
18	+ 5·57	+70·9	−16·15	−69·0	19·55	40·4
19	+ 0·06	+68·8	−13·74	−84·7	−22·33	+33·7
20	− 5·43	+55·3	−10·44	−95·0	24·95	26·8
21	−10·03	+32·8	− 6·51	−99·3	−27·39	+19·7
22	−13·04	+ 5·3	− 2·18	−97.4	29·63	12·5
23	−14·05	−23·0	+ 2·26	−89·4	−31·66	+ 5·2
24	−12·99	+47·9	+ 6·54	−75·5	33·46	− 2·2
25	−10·03	−65·8	+10·35	−56·5	−35·03	− 9·4
26	− 5·73	−74·3	+13·37	−33·4	36·35	16·6
27	− 0·59	−72·4	+15·28	− 7·6	−37·42	−23·6
28	+ 4·60	−60·2	+15·78	+18·8	38·23	30·4
29	+ 9·11	−39·3	+14·69	+43·1	−38·77	−37·0
30	+12·25	−12·7	+11·96	+62·5	39·05	43·4
31	+13·49	+15·7	+ 7·80	+74·2	−39·07	−49·4
April 1	+12·59	+41·5	+ 2·69	+76·7	38·82	55·0
2	+ 9·65	+60·4	− 2·74	+69·6	−38·32	−60·3
3	+ 5·11	+69·2	− 7·83	+54·2	37·57	65·1
4	− 0·25	+66·5	−12·05	+32·9	−36·57	−69·5
5	− 5·56	+52·8	−15·06	+ 8·3	35·33	73·4
6	− 9·96	+30·6	−16·68	−16·9	−33·87	−76·8
7	−12·78	+ 3·6	−17·01	−40·7	32·19	79·7
8	−13·64	−23·8	−16·06	−61·4	−30·32	−82·0
9	−12·52	−47·6	−14·02	−77·9	28·26	83·8
10	− 9·60	−64·5	−11·07	−89·2	−26·03	−85·1
11	− 5·33	−72·3	− 7·45	−94·9	23·65	85·8
12	− 0·34	−69·8	− 3·38	−94·8	−21·12	−86·0
13	+ 4·68	−57·5	+ 0·89	−88·7	18·48	85·7
14	+ 9·01	−37·0	+ 5·07	−77·0	−15·74	−84·5
15	+11·98	−11·1	+ 8·90	−60·0	12·91	83·4
16	+13·10	+16·4	+12·06	−38·8	−10·01	−81·
17	+12·14	+41·1	+14·24	−14·6	7·06	79·1
18	+ 9·21	+59·0	+15·14	+10·8	− 4·09	−76·2
19	+ 4·77	+67·1	+14·55	+34·9	+ 1·11	73·0

Greenwich Noon, 1888.	$\alpha_6-A.$	$\delta_6-D.$	$\alpha_7-A.$	$\delta_7-D.$	$\alpha_8-A.$	$\delta_8-D.$
	s	″	s	′	s	″
April 20	− 0·44	+63·9	+12·38	+55·1	+ 1·87	−69·3
21	− 5·57	+50·5	+ 8·75	+68·7	4·83	65·2
22	− 9·79	+28·6	+ 4·06	+73·6	+ 7·74	−60·7
23	−12·46	+ 2·5	− 1·12	+69·4	10·60	55·9
24	−13·25	−23·8	− 6·16	+56·8	13·39	−50·9
25	−12·09	−46·6	−10·49	+38·0	16·09	45·6
26	− 9·22	−62·6	−13·75	+15·3	+18·68	−40·1
27	− 5·06	−69·7	−15·75	− 8·7	21·16	34·4
28	− 0·21	−67·1	−16·45	−31·9	+23·51	−28·5
29	+ 4·65	−54·9	−15·92	−52·6	25·71	22·6
30	+ 8·82	−34·9	−14·30	−69·5	+27·76	−16·6
May 1	+11·67	− 9·9	−11·75	−81·9	29·65	10·5
2	+12·71	+16·5	− 8·48	−89·1	+31·37	− 4·4
3	+11·74	+40·2			32·90	+ 1·7
4	+ 8·87	+57·1			+34·24	+ 7·7
5	+ 4·54	+64·6			35·38	13·6
6	− 0·52	+61·3			+36·32	+19·3
7	− 5·49	+47·9			37·05	24·9
8	− 9·56	+26·9			+37·57	+30·4
9	−12·13	+ 1·8			37·88	35·6
10	−12·87	−23·4			+37·97	+40·5
11	−11·73	−45·1			37·85	45·1
12	− 8·93	−60·3			+37·51	+49·5

Ephemeris of the Satellite of Neptune, 1887–88. By A. Marth.

Greenwich Noon.	P′	*a*	*b*	*u*−U	Diff.	U	B
1887.	°	″	″	°	°	°	°
Oct. 25	322·70	16·92	8·29	169·36	612·32	131·73	−29·34
Nov. 4	322·51	16·95	8·28	61·68	·30	132·00	29·23
14	322·30	·97	·26	313·98	·28	132·29	29·12
24	322·07	·97	·23	206·26	·27	132·58	29·00
Dec. 4	321·84	16·96	8·19	98·53	·28	132·87	28·88
14	321·62	·92	·14	350·81	·29	133·14	28·76
24	321·43	·87	·09	243·10	·33	133·38	28·65
1888.							
Jan. 3	321·27	16·81	8·04	135·43	612·36	133·58	−28·56
13	321·14	·73	7·98	27·79	·41	·74	·48
23	321·06	·65	·92	280·20	·46	·85	·43
Feb. 2	321·02	16·56	7·87	172·66	·52	133·90	28·39
12	321·02	·46	·83	65·18	·57	·89	·38
22	321·07	·37	·79	317·75	·64	·82	·40
Mar. 3	321·17	16·28	7·75	210·39	·69	133·69	28·45
13	321·31	·19	·73	103·08	·74	·51	·51
23	321·49	·11	·71	355·82	612·80	·28	·60
Apr. 2	321·70	16·04	7·70	248·62		133·01	−28·71

P′ position-angle of the minor axis of the satellite's apparent orbit, in the direction of superior conjunction.

a, *b*, major and minor semi-axes of the apparent orbit.

u−U, longitude of the satellite in its orbit, reckoned from the point which is in superior conjunction with the planet or in opposition to the earth.

U + 180°, planetocentric longitude of the earth, reckoned in the satellite's orbit from the ascending node on the celestial equator.

B, planetocentric latitude of the earth above the plane of the orbit.

The values of *u*−U, P′, *a*, *b* are to be interpolated directly for the times for which the apparent positions of the satellite are required, and the position-angles *p* and distances *s* of the satellites are then found by means of the formulæ

$$s \sin (P' - p) = a \sin (u - U)$$
$$s \cos (P' - p) = b \cos (u - U).$$

The satellite moves in the direction of decreasing position-angles and will be at its greatest elongations (*nf* in pos. P′ + 90°, *sf* in pos. P′ − 90° at dist. *a*) and at its nearest conjunc-

tions (superior *sup.* in pos. P′, inferior *in.* in pos. P + 180° at dist. *b*) with the planet at the following Greenwich hours:

1887.		h		1887.		h		1888.		h	
Oct.	25	4·2	in.	Dec.	15	14·9	sp.	Feb.	3	14·1	nf.
	26	15·4	nf.		17	2·2	in.		5	1·4	sup.
	28	2·7	sup.		18	13·4	nf.		6	12·7	sp.
	29	14·0	sp.		20	0·7	sup.		7	23·9	in.
	31	1·3	in.		21	12·0	sp.		9	11·2	nf.
Nov.	1	12·5	nf.		22	23·3	in.		10	22·5	sup.
	2	23·8	sup.		24	10·5	nf.		12	9·7	sp.
	4	11·1	sp.		25	21·8	sup.		13	21·0	in.
	5	22·4	in.		27	9·1	sp.		15	8·3	nf.
	7	9·7	nf.		28	20·4	in.		16	19·5	sup.
	8	20·9	sup.		30	7·6	nf.		18	6·8	sp.
	10	8·2	sp.		31	18·9	sup.		19	18·0	in.
	11	19·5	in.	1888.					21	5·3	nf.
	13	6·8	nf.	Jan.	2	6·2	sp.		22	16·6	sup.
	14	18·0	sup.		3	17·5	in.		24	3·8	sp.
	16	5·3	sp.		5	4·7	nf.		25	15·1	in.
	17	16·6	in.		6	16·0	sup.		27	2·3	nf.
	19	3·9	nf.		8	3·3	sp.		28	13·6	sup.
	20	15·2	sup.		9	14·6	in.	Mar.	1	0·8	sp.
	22	2·4	sp.		11	1·8	nf.		2	12·1	in.
	23	13·7	in.		12	13·1	sup.		3	23·3	nf.
	25	1·0	nf.		14	0·4	sp.		5	10·6	sup.
	26	12·3	sup.		15	11·6	in.		6	21·9	sp.
	27	23·5	sp.		16	22·9	nf.		8	9·1	in.
	29	10·8	in.		18	10·2	sup.		9	20·4	nf.
	30	22·1	nf.		19	21·5	sp.		11	7·6	sup.
Dec.	2	9·4	sup.		21	8·7	in.		12	18·9	sp.
	3	20·7	sp.		22	20·0	nf.		14	6·1	in.
	5	7·9	in.		24	7·3	sup.		15	17·4	nf.
	6	19·2	nf.		25	18·5	sp.		17	4·6	sup.
	8	6·5	sup.		27	5·8	in.		18	15·9	sp.
	9	17·8	sp.		28	17·1	nf.		20	3·1	in.
	11	5·0	in.		30	4·3	sup.		21	14·4	nf.
	12	16·3	nf.		31	15·6	sp.		23	1·6	sup.
	14	3·6	sup.	Feb.	2	2·9	in.		24	12·9	sp.

The only observations of the satellite made during the last apparition, which have yet come to my knowledge, are those made by M. Perrotin with the great refractor of the Nice Observatory and published in the August number of the Paris Bulletin Astron. v. 4, p. 341. In the present ephemeris the plane of the orbit is assumed in accordance with these measures, which give approximately for 1888 N = 185°.260 J = 120°300.

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